

Vol
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NEW JUNIOR ENCYCLOPEDIA

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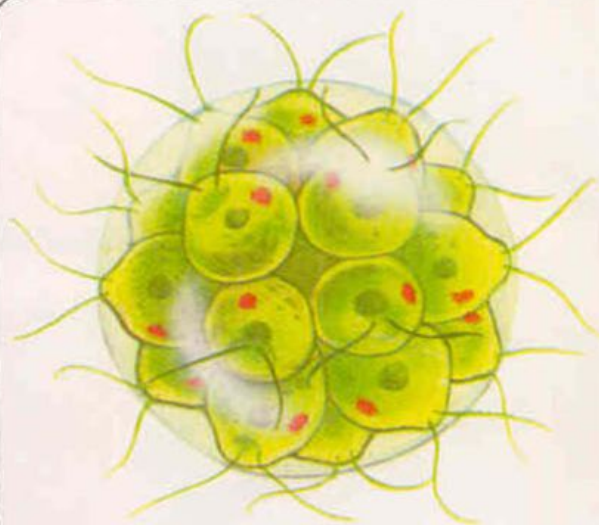
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A

Aardvark is a large, timid, burrowing animal that lives in central and southern Africa. It is also called *antbear*, and *earth pig*. When fully grown, it is about the size of a pig, with donkey-like ears, long head and snout, long sticky tongue, and short legs armed with powerful claws.

The aardvark feeds by night on *termites* (soft-bodied insects that look like white ants). Termite mounds, of hard-packed clay, may reach 6 feet in height, but the aardvark soon tears them apart with its front legs. As the insects rush out, the aardvark scoops them up by the hundreds with its specially adapted tongue.

Abacus An abacus is a frame of beads on wires, used for counting and for simple mathematical calculations. Its principle was known to the ancient Assyrians, and early Greeks and Romans used the bead-frame abacus. Today in Western countries it is used as a toy or to teach counting to young children. But in Eastern countries it is still used in shops, offices, and even in banks. The Chinese call it *suan pan* and the Japanese *soroban*.

Counting on an abacus is rather like counting on the fingers. For instance a simple frame may have rows of ten beads,



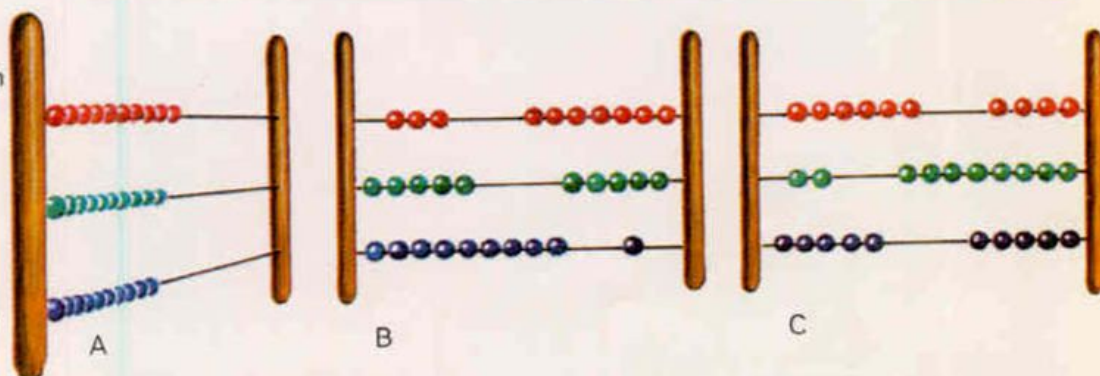
The aardvark is a night-hunting animal. Its short front legs have powerful claws; with them it rips open the nests of termites.

each row from right to left standing for units, tens, hundreds, and so on. A modern Japanese abacus has only five beads instead of ten, each group of five being split into four and one by a bar across the frame. In the units 'column', the four beads count as 1, 2, 3 and 4 while the single bead counts as 5. It can be used for multiplying and dividing as well as for adding and subtracting.

Abdul Rahman, Tunku (1903-), was the first prime minister of Malaya and later of Malaysia. He was one of the leading statesmen of South-East Asia until his retirement in 1970.

Abdul Rahman, the son of the sultan of Kedah, was educated partly in England. He became a civil servant, and in 1951 was elected president of an organization working for independence from British rule. Later he led the Alliance Party, which won nearly all the seats in the Federal Legislative Council during Malaya's first elections in 1955. He helped to negotiate Malaya's independence, and

A simple abacus (A) has three rows of beads which count as one each, ten each, and one hundred each. In addition (B), beads are moved across from the left giving a total on the right. In subtraction (C), beads are taken away from the left leaving the remainder on the left.



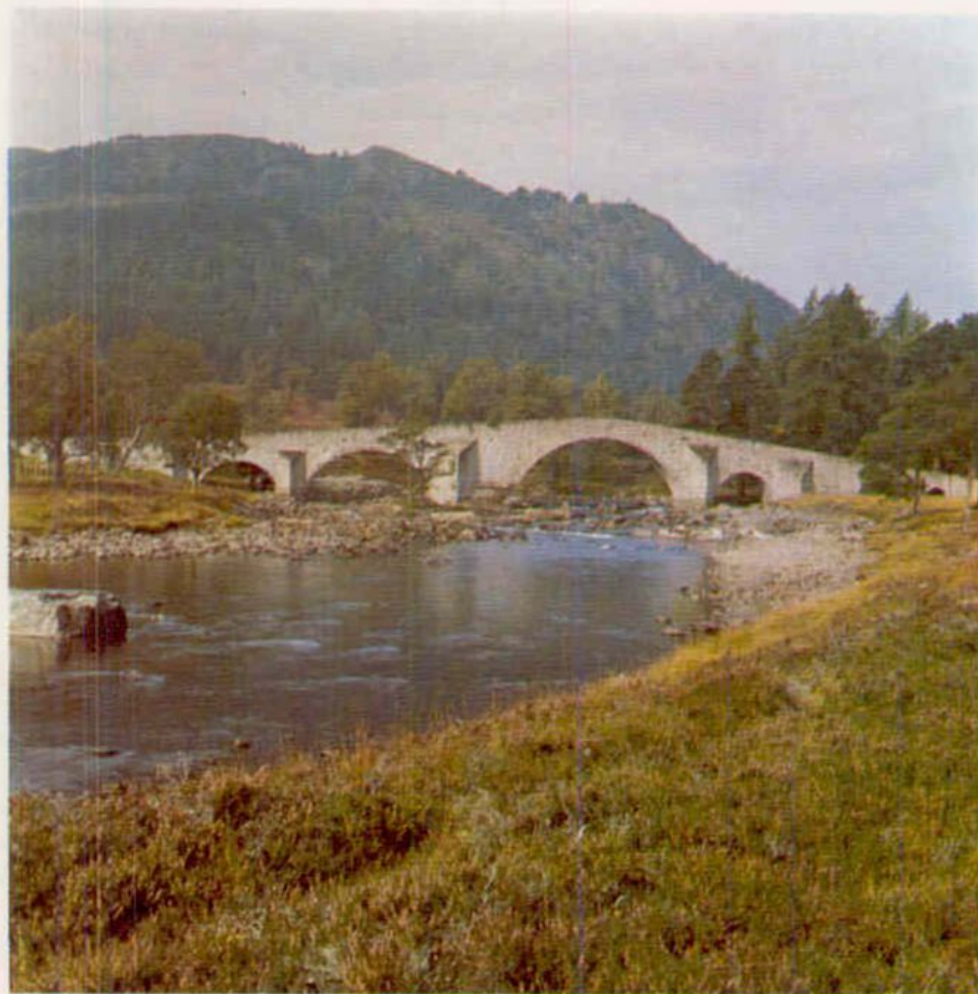
became prime minister in 1957. In 1963 he was chosen as prime minister of the new federation of Malaysia, consisting of Malaya, Singapore (until 1965), Sarawak, and Sabah. One of his most difficult tasks was to counter Indonesia's hostility to Malaysia. With British help, the Malaysians defeated an Indonesian invasion of Sarawak and Sabah in 1964.

Aberdeenshire, a county in north-eastern Scotland, has a long coastline on the North Sea. In the coastal areas of the north and east the land is low-lying. But the Grampian mountains extend into the south-west of the county, and in the west the Cairngorms give Aberdeenshire some of Britain's most spectacular mountain scenery. The county has two rivers that are celebrated in Scottish song and legend: the Don and the Dee. Aberdeen, the 'Granite City', at the mouth of the Dee, is the county town. The area of Aberdeenshire is 1,960 square miles.

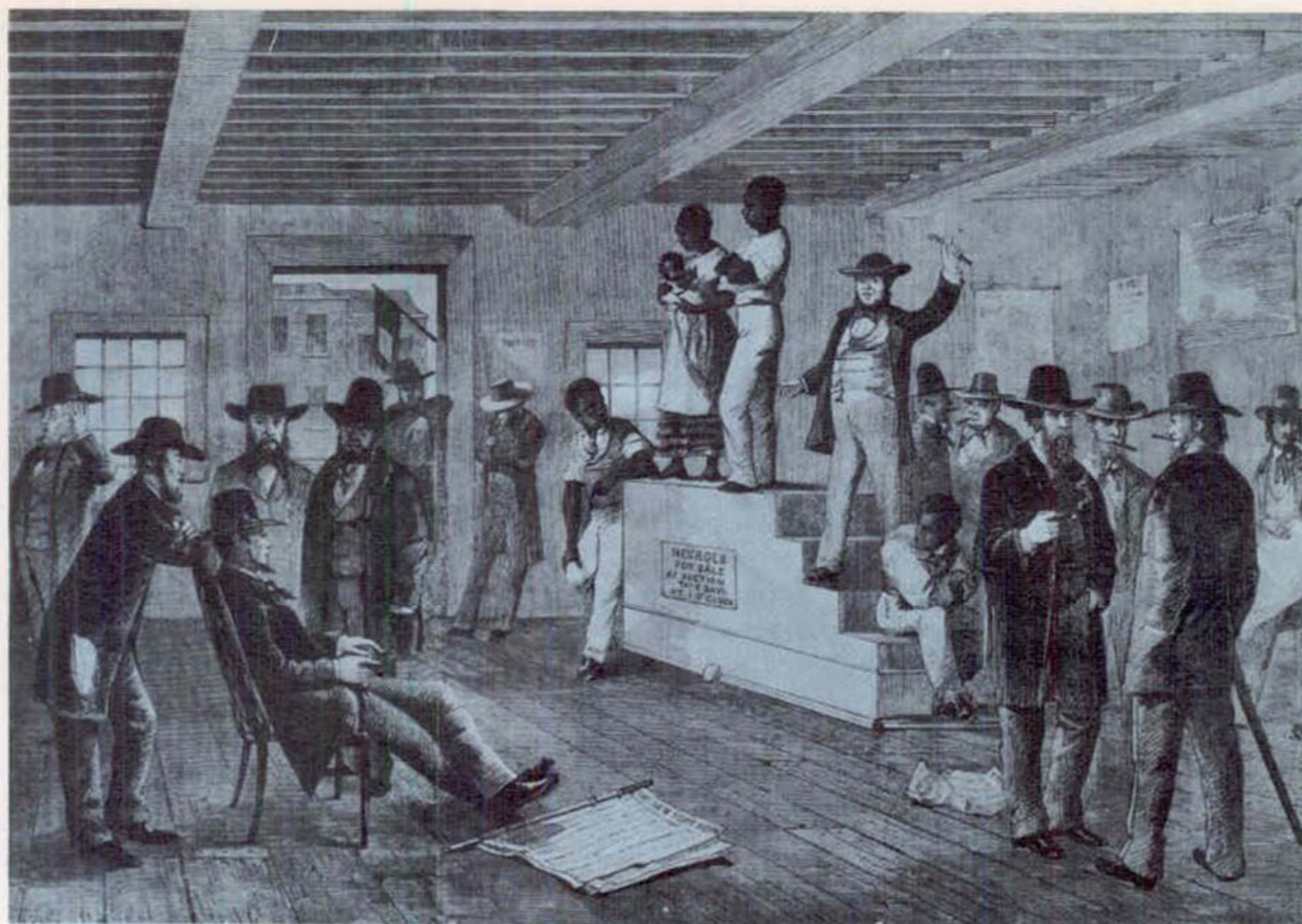
The chief towns are in the coastal lowlands. Aberdeen, long famous for its university, its fishing industry, and its boat building, has become known as an oil town since the discovery of petroleum in the North Sea. Peterhead and Fraserburgh, farther north, are among the most active fishing ports in Britain. But in most parts of the county people gain their living from farming. In lowland areas, farmers grow cereals and potatoes. In upland areas, they raise sheep and, in particular, beef cattle that are highly valued.

Aberdeenshire has many deer forests. Balmoral Castle, a royal residence, is on the River Dee about 50 miles west of Aberdeen. The Highland Games are held at nearby Braemar and at Aboyne.

Abolitionists was the name given to people in the 1700's and 1800's who worked for the abolition of slavery. The abolitionists had two chief aims: firstly, to put an end to the slave trade—that is,



The old bridge of Dee at Invercauld, Aberdeenshire. The name Aberdeen means 'mouth of the Dee'. Aberdeenshire is the most easterly county of the mainland of Scotland.



to make it illegal for slavers to capture people and sell them as slaves; and secondly, to set free all those who were already in slavery.

In 1772 an English court decided that no person could legally be held as a slave in England. William Wilberforce led a campaign in Parliament to outlaw the slave trade. In 1807, Parliament finally prohibited dealings in slaves. Denmark had already made slaving illegal, in 1792. In 1794, the United States prohibited slave trading with foreign countries, and in 1807 forbade the importing of slaves.

The next step was to gain freedom for existing slaves. An Act of 1833 set all slaves in the British Empire free by 1840. The French put an end to slavery in their territories in 1848, and the Dutch in 1863. In the United States, the American Anti-Slavery Society gained supporters in all parts of the country in the 1830's and 1840's. Many of its members joined the Republican party. In 1861 Abraham Lincoln, one of the apostles of anti-slavery,

Slave auctions were typical of the slavery system that flourished in the southern United States during the early 1800's. From the 1830's, free blacks joined with abolitionists in condemning the idea on which slavery was based, namely that people could be owned, bought and sold like cattle or furniture.

became the first Republican president of the United States. Slavery was finally abolished in the United States after the Civil War of 1861 to 1865, by Amendment 13 to the United States Constitution.

Aborigines are the earliest known inhabitants of a country. The word comes from the Latin, meaning 'from the beginning'. It is applied particularly to the native peoples of countries such as Australia, which were later settled by Europeans.

Some Australian Aborigines probably came from south-eastern Asia at least 32,000 years ago. Although they wandered all over the continent, most of them stayed in central and northern Australia.

For centuries the Aborigines survived in places and under conditions that would have defeated Europeans—from the



These Australian aborigines have painted themselves with elaborate traditional patterns in preparation for a *corroboree*, or party. Their name comes from the Latin *ab origine*, meaning from the beginning; the term is given to the first inhabitants of any country. It is most commonly used for the original inhabitants of Australia.

northern jungles to the scorching deserts of central Australia. As a result, they became wanderers, living off the land. They were expert trackers, hunters, fishermen, and food-gatherers.

The Aborigines lived very simply, often completely naked. They slept out in the open and stayed in small groups. Their chief weapons were the *boomerang* (a curved throwing-stick) and the *woomera* (a spear-thrower). All their tools were made of natural materials, such as wood, stone, shell, and bone.

Parties called *corroborees* celebrated tribal visits. In addition to feasting, there was much rhythmic music, dancing, and miming. The Aborigines were also original artists.

Today's Aborigines have chocolate

brown skins and dark wavy hair. Their eyes are deep-set under low brows. Their lean, strong bodies are of about average European height. In the early 1900's it was feared that they were a dying race because they seemed unable to adapt to advancing civilization. But today, most of the 40,000 surviving Aborigines live in protected reserves, with rights as Australian citizens, their welfare assured, and with opportunities for education and employment.

Abraham was a *patriarch* (a father and ruler of a family or tribe) who flourished about 1700 B.C. He is regarded as the founder of the Jewish race, and his story is told in the Bible, in the Book of Genesis, chapters 11 to 25.

He was born and lived in Ur of the Chaldees, an ancient city of Mesopotamia.

Aborigines were once thought restless people, because they never stayed long in one place. Their 'walkabouts' were really seasonal moves in search of food and water.

Right: God tested Abraham by telling him to sacrifice his son Isaac. Abraham's faith was so great that he was about to kill the boy when God sent a ram instead.



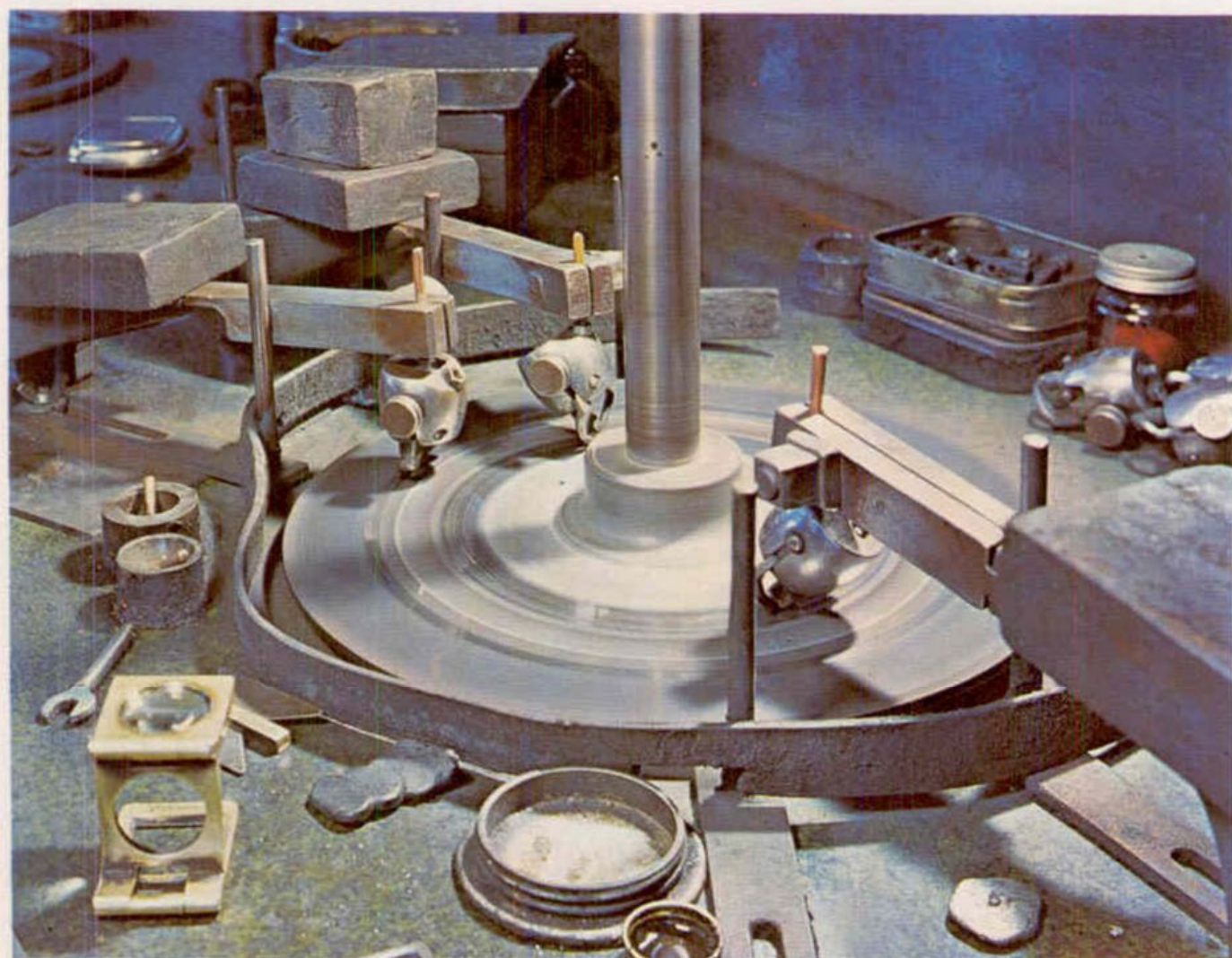
At the age of 75, in obedience to God's command, he travelled to the Land of Canaan (which today is called Palestine), taking his whole household with him. God promised Abraham that his descendants would inherit forever the land in which he eventually settled.

As a test of his obedience, Abraham was told to sacrifice his favourite son Isaac. The boy's life was spared at the last minute after his father had shown complete faith in God.

Abrasives are minerals used for grinding, polishing, and sharpening other materials.

rough work, while softer substances and finer grinds are used for finishing, polishing and buffing.

Diamond is the hardest naturally occurring substance, and can also be produced synthetically. Synthetic diamonds are used to make cutting tools, and are ground into a dust for use in polishing. Carborundum (silicon carbide) is a widely used synthetic abrasive made from sand and coke. Pumice, a product of volcanic action, is one of the softer abrasives. Chalk, quartz and corundum (aluminium oxide) are other abrasives commonly used.



They include grinding stones and grinding wheels used for milling grain and sharpening knives and tools; sandpaper and emery cloth; and powdered abrasives, which are often mixed with liquid or paste, as in toothpaste. In general, hard substances and coarse grinds are used for

Polishing diamonds with an abrasive wheel. Grinding wheels are made by setting the crushed abrasive in clay and then firing it.

Absolute zero is a temperature so low that nothing can be cooled below it. Scientists say that at this point a substance would contain no heat energy

whatsoever, which means that its molecules would no longer move.

Absolute zero occurs at -273° on the Centigrade or Celsius scale and at -460° on the Fahrenheit scale. Scientists who work with low temperatures usually use the *Kelvin* or *absolute scale* which has its zero point at absolute zero.

Because absolute zero is a theoretical value, it cannot actually be reached in experiments. Scientists have, however, succeeded in cooling certain metals to within fractions of a degree of absolute zero. At such low temperatures they find unusual properties, such as *superconductivity*, an abnormally high ability to conduct electricity.

Acceleration is a measure in physics that tells how fast the speed of a moving object changes during a certain period of time. For example, a car that goes from standstill to 40 miles per hour in 4 minutes is accelerating at a rate of 10 miles per hour per minute. Its rate of acceleration is faster than another car going from 0 to 40 miles per hour in 6 minutes.

An object whose speed is increasing is showing *positive acceleration*, but there can also be *negative acceleration*. This means slowing down in speed, as when the brakes are applied to a car. When an object moves at a constant speed, no matter how fast, there is no acceleration either positive or negative.

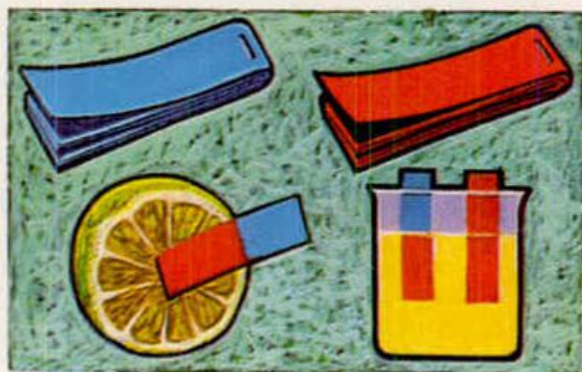
Another example of acceleration is shown by the movement of falling bodies caused by gravity (the attractive force of the Earth). Gravity exerts a constant pull on objects which makes them fall with a uniform acceleration of 32 feet per second at sea level (there are slight differences at different altitudes). The Italian scientist Galileo, in the late 1500's, was the first to prove that all objects fall at the same rate. He did this by dropping metal balls of different weights from a high tower and observing that they hit the ground at the same time.

We now know that this observation strictly holds true only in a vacuum where air resistance cannot interfere. In a vacuum, a bag of feathers and a lead ball do fall with equal acceleration, though under ordinary conditions the lead falls faster. The degree of acceleration caused by gravity explains why even a relatively light object can give a nasty blow when dropped from high up.

Achilles was a legendary hero of ancient Greece in the war between the Greeks and Trojans. (See Troy.) Although brave and fearless, Achilles refused to fight a battle against the Trojans after quarrelling with Agamemnon, the Greek commander. The Trojans won, and Achilles sent Patroclus to fight them. When Patroclus was killed, Achilles rushed into the battle and killed the Trojan leader Hector.

This figure of Achilles comes from a Greek vase. He was one of the most famous heroes of the Trojan War, and killed Hector, his Trojan rival.





It is possible to tell whether a solution is acidic by testing it with blue litmus paper. Litmus is one of the substances called indicators. Any solution which changes the colour of litmus from blue to red is sure to contain some kind of acid. Red litmus paper (right) is unaffected by acids.



Grapes Contain Tartaric Acid

Most organic acids—those obtained from living things—are weak and generally harmless. In fact we eat them in the form of fruit and in vinegar.



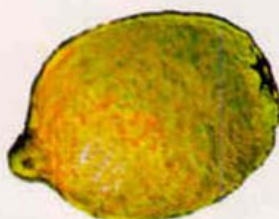
Rhubarb Leaves Contain Oxalic Acid (Poison)



Vinegar Contains Acetic Acid



Unripe Apples and Pears Contain Malic Acid



Citrus Fruits, such as Oranges and Lemons, Contain Citric Acid

Achilles was supposed to be the son of Peleus and Thetis. His mother Thetis, wishing to make Achilles *invulnerable* (impossible to wound), dipped him into the River Styx. Every part of him became invulnerable except for the heel by which Thetis had held him. Achilles died from a wound in this heel caused by an arrow shot by Paris. From this, we still use the phrase *Achilles' heel* to refer to the weak point in a person's character or a nation's strength. The story of Achilles originated in or before the 900's B.C., when Homer's *Odyssey* and *Iliad* were written.

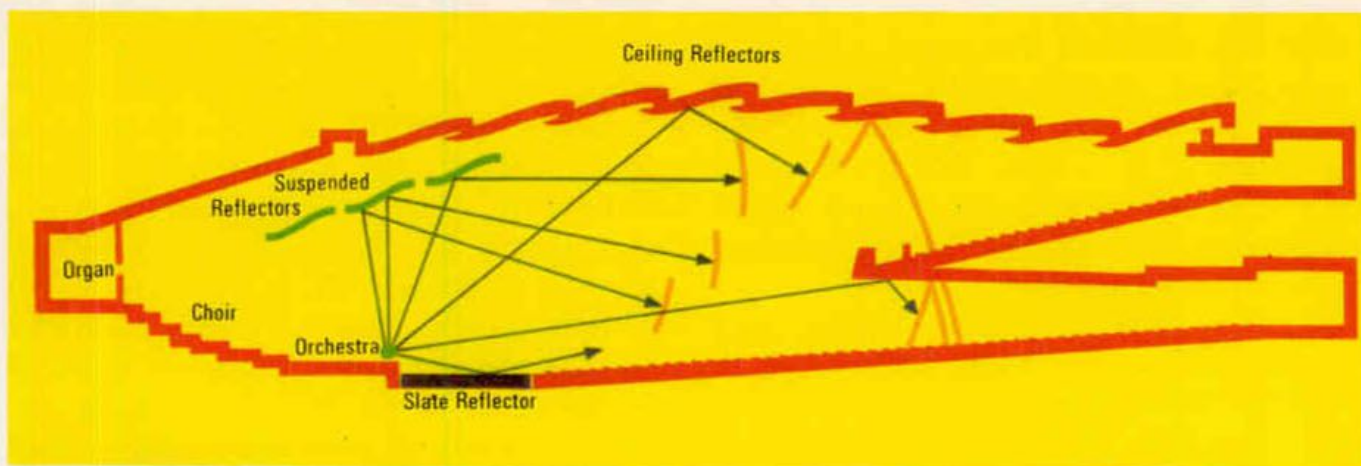
Acids are a group of chemicals that are known for their sour taste. Some of the acids are very dangerous. *Sulphuric acid*, for example, is highly *corrosive*—it can eat away most metals. And it will quickly burn into flesh and other living matter. *Nitric acid* and *hydrochloric acid* are two other acids that will attack most metals. These three strong acids are among the most important of all the chemicals used in industry—sulphuric acid especially (see Sulphur).

Acids, bases and salts form three of the most important classes of chemical compounds. They are connected in the following way. An acid reacts with a base to give a salt and water. This is one of the fundamental rules in chemistry.

Hydrochloric acid, for example, combines with sodium hydroxide (base) to form sodium *chloride* (salt) and water. Sulphuric acid combines with potassium hydroxide (base) to form potassium *sulphate* (salt) and water. In a similar way nitric acid reacts to produce a *nitrate*. (See Alkalis; Salt.)

One way acids and bases differ is in their action towards a litmus solution. *Litmus* is one of the substances called *indicators*, which have one colour in an acid solution and another colour in an alkaline solution. In an acid solution, litmus is red; in an alkaline solution it is blue.

The three acids mentioned so far are



Modern auditoriums are carefully designed to have good acoustic properties. Above: A section through a concert hall showing where the sound waves are reflected.

Left: A modern concert hall based on this design.



inorganic compounds. There are also *organic* acids—those which contain carbon atoms. In general, organic acids are very much weaker than inorganic acids, and they are also very much more common. For example, vinegar is a weak solution of an organic acid called *acetic* acid. The sharp taste in citrus fruits such as lemons is caused by *citric* acid. When an ant stings us, it injects *formic* acid into the skin, which causes pain. *Lactic* acid causes the sourness when milk 'goes off'. Proteins, which living things need to build up tissue, are made up of *amino* acids.

Aconcagua is an extinct volcano in the Andes mountains of South America, generally regarded as the highest peak in the western hemisphere. It stands in western Argentina, close to the border with Chile, and reaches a height of 22,831 feet. The permanent snow line starts about 16,000 feet up, and the southern slopes are covered with glaciers.

Aconcagua is one of the great tourist attractions of South America. It towers over the Trans-Andean Railway between Argentina and Chile, and the Pan-American Highway linking those countries. It was first climbed in 1897.

Acoustics In designing a concert hall or theatre, the architect must carefully consider the *acoustics* (quality of sound) of the building. Will the full range of sound waves reach every seat in the auditorium? Will there be too much reflection, or is too much sound going to be absorbed by the walls and ceiling?

Sound waves travel in straight lines and will go out from their source in all directions. But in much the same way as with light, sound waves can be reflected or absorbed by surfaces which they strike.

The quality of the sound depends largely on the proportion of those waves

reaching the listener directly and those which are reflected. Too many echoes are undesirable. Consequently, the height of the roof of the concert hall and the curvature of its surface have to be carefully chosen so that the sound waves reaching it are reflected back to produce the most pleasing effect.

Various reflectors and baffles may be attached to the walls and ceiling to turn the sound waves in the most desirable direction. It is often necessary to have reflectors above the platform to direct the sound towards the body of the hall.

The presence of an audience has a considerable effect upon the acoustics of many concert halls, as the members of the audience are themselves quite good absorbers of sound waves. This particular problem can be overcome with tip-up seats so designed that when empty they have similar absorption properties to those of the audience who may occupy them.

Adelaide is the chief city and capital of the state of South Australia. It lies on the banks of the River Torrens, six miles inland from the St Vincent Gulf.

The huge metropolitan area now stretches for some 40 miles along the Adelaide Plains, and contains about 760,000 people. About a fifth of them came to Australia from Europe only after World War II.

Adelaide was first settled in 1836, and was named after Queen Adelaide, wife of the then British King William IV. A central position, ease of communications, and nearby mineral resources have all contributed to its growth. It is an important centre of Australia's export trade, handling the bulk of the produce of the surrounding plains which are a rich cereal, wool and fruit producing area. Adelaide also has a number of industries, including metal working, engineering, and the manufacture of household appliances.

The central part of the city is laid out with broad, tree-planted streets, and the botanical garden and its park cover more than 120 acres. It has fine public buildings, two universities, cathedrals, and an Institute of Technology.

Adhesives are substances used for sticking things together. The adhesive is usually spread thinly on the two surfaces, which are then pressed together. After the adhesive dries, the bond is more or



Adelaide, capital of South Australia, was planned in 1836 by Colonel William Light. Although it now has many modern buildings, the centre is still surrounded by parks as in Light's original plan.

less permanent. Using a thick coating of adhesive makes the joint weaker, not stronger.

Natural substances of many kinds have been used as adhesives. Some have been used since prehistoric times. One of the most important for cabinet-making and woodwork is animal glue, made from the gelatin in bones, hooves, and hides. This glue is usually stored in sheets or is ground up, ready to be mixed with water and heated when needed. Casein glue, made from milk, is also used in wood-working and as an adhesive for paper.

Starches such as flour and water make surprisingly good pastes for paper. They are also used to make papier mâché dolls and decorative objects.

Certain trees produce sticky gums and resins that are useful as adhesives. Gum arabic, used for stamps and gummed labels, is one of these. Rubber adhesives are used for holding floor and ceiling tiles.

Synthetic adhesives are relatively new—they have only been manufactured since the 1930's. Some synthetic products, such as epoxy resins, are so strong that they can be used in making aeroplanes and boats, where riveting or welding once had to be used.

Other synthetic adhesives include artificial rubbers, plastic, and vinyls. These can be manufactured specially for use on non-porous surfaces or with particular qualities such as resistance to heat or water.

Advertising is a means of telling people about goods or services that they can buy or can otherwise obtain. Generally, a person or company that advertises is trying to sell something: shops and stores advertise the articles they have in stock, cinemas advertise their current and future programmes, window cleaners advertise the service they offer, and the car owner who is changing cars advertises his old vehicle for sale. But people also advertise for other reasons: for example, charities advertise to gain support for



Brilliant neon advertising signs and huge posters are used in public places like Piccadilly Circus, London.

their work, and employers advertise for staff.

The most popular *media* (means of advertising) are those that reach the greatest number of people, chiefly television, radio, newspapers, and magazines. Advertising posters, too, are very common. They can be seen everywhere in our cities: on hoardings, on special advertising pillars in the street (as in France and Germany), in railway stations and airports, and in buses and trains. Many of them are interesting and even beautiful. Others are vulgar and silly.

Today, advertising is a huge industry that employs millions of people, including artists, researchers, writers, photographers, actors, and salesmen. Many of the people who work in advertising are employed by advertising agencies—firms specializing in producing advertisements on behalf of clients who have goods or services to sell. Agencies carry out market research, to find out what products members of the public like and want, and what kinds of advertising are the most effective. They advise their clients on the most suitable media, and prepare the advertisements.

Advertisers try to make the products they are selling sound as desirable and as

good value as possible. To guard against false claims that mislead the public, many countries have laws that control advertising.

Talking points

* How do you think advertising makes people's lives easier and more pleasant? Consider health information, road and safety posters etc. as well as commercial advertising.

* Advertisements can misinform. Can you think of ways in which they can distort truth without actually telling lies?

Political posters, for instance, will put forward a one-sided view.

* Advertisements are very expensive to produce. Yet they help to make the goods and services they are advertising cheaper. Can you find out why?

Articles to read:

Communications, Newspapers, Propaganda, Radio.



In an aerosol container, a solution of liquefied gas and the substance to be sprayed is kept under high pressure. When the cap is pressed, a valve opens and the solution moves up through the plunger to the nozzle. The gas turns into vapour and the solution comes out as a fine spray.

Aerosol is the name for a cloud of very tiny particles floating in air or some other gas. The particles may be liquid, as in mist, or solid, as in smoke.

When people speak of an aerosol they usually mean a device for spraying such substances as cosmetics, paints, or insecticides. The device consists of a can containing a liquefied gas under high pressure. The can also contains the cosmetic or other substance to be sprayed.

When the cap of the can is pressed, a fine nozzle opens. Because of the pressure, the gas is forced out, carrying with it the other substance in the form of an aerosol spray.

Aesop (about 620-560 B.C.) was a Greek storyteller. His stories, based on old Greek, Indian and other tales, are today known as *Aesop's Fables*. His characters were often animals, but their behaviour illustrates human virtues and weaknesses. One tale tells of a race between a tortoise and a hare. The tortoise won because the hare was over-confident and took a rest before reaching the finishing line. Historians believe that Aesop was a slave who was freed because he told stories so skilfully.

Afghanistan is a land-locked Muslim kingdom of southern Asia. Most Afghans are farmers or craftsmen who live outside the few towns. Afghanistan is bordered by Russia, China, Pakistan and Iran.

Mountains cover nearly three-quarters of Afghanistan. The snow-capped Hindu Kush reaches 25,000 feet above sea-level near Pakistan. Much of the land is desert. Afghanistan has about 12 inches of rainfall every year. Temperatures vary from freezing point in Kabul in January, to 120°F (49°C) in the deserts of the south-west in July.

Only about one-fiftieth of Afghanistan's land area—the fertile mountain valleys—can be farmed. Miners work deposits of several minerals, and the country has a few small manufacturing industries.

Greek, Arab, Mongol and Persian armies each occupied Afghanistan in turn. Russia and Britain competed for influence in Afghanistan in the 1800's, and British armies from India fought several frontier wars with Afghanistan.

After Pakistan became independent in 1947, Afghanistan disputed its frontiers. Afghanistan claimed that *Pathan* tribesmen, who live in both countries, should be able to form their own state. The dispute continued into the 1970's.

Facts and Figures

Area: 250,000 square miles.

Population: 17,000,000 (estimate).

Capital: Kabul.



Left: An Afghan girl in traditional dress.

Right: Location map of Afghanistan (black).



Below: The people of Afghanistan are noted for their fierce independence, and during the country's turbulent history they have gained a reputation as fearless fighters.



Africa is the world's second largest continent. With its area of 11,671,000 square miles, it is three and a half times as large as the United States. But Africa has only 345,000,000 people. The United States has about twice as many people to every square mile.

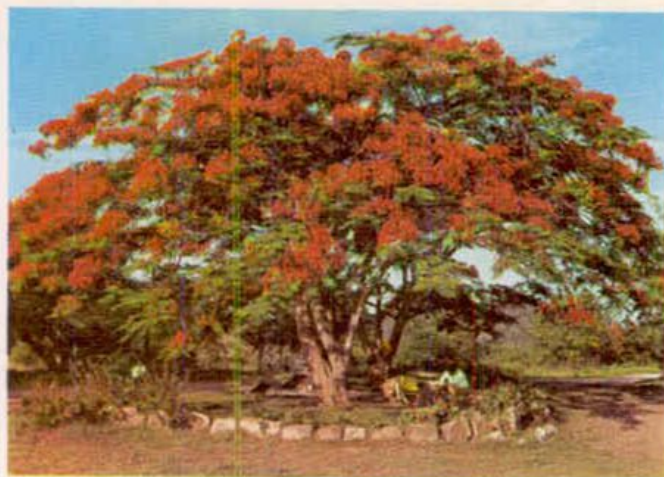
Large parts of Africa are almost empty wastelands. Great, burning-hot deserts, including the Sahara in the north and the Namib and Kalahari in the south, cover about two-fifths of Africa. Life is only possible where water is available. For example, nearly all Egyptians live in the valley of the River Nile. Either side of this valley is empty desert.

Near the Equator, especially in western and west-central Africa, the rainfall is very heavy, sometimes more than 150 inches a year. This hot, rain-drenched region is covered by thick, luxuriant forests. The trees grow so close together that their leaves blot out the sun.

Although most of Africa lies within the tropics, more than a third of the continent is a great *plateau* (high plain). Because they are so high, many parts of Africa close to the Equator have a pleasant climate. Travellers going inland from the steaming-hot seaports of Mombasa and Dar-es-Salaam in eastern Africa climb steeply to the plateau. Average temperatures fall at a rate of about 1° F for every 330 feet. In eastern Africa are the continent's two highest mountains, Kilimanjaro in Tanzania (19,340 feet above sea level) and Mount Kenya (17,058 feet). Snow and ice cap the peaks of these mountains.

Grassland called *savanna* covers much of the high plains of Africa. Great herds of animals still roam over Africa's grasslands and forests. In the past, thousands of animals were killed by hunters and poachers. To save the animals, many African governments have set up special parks and game reserves.

Throughout the eastern African plateau runs the deep African rift valley. This colossal valley stretches from Syria



Above: The Flamboyant tree, a native of southern Africa.

Right: A Masai warrior. The Masai live on the high plains of east-central Africa. The men hunt while the women farm. Only the warriors are allowed to grow their hair.

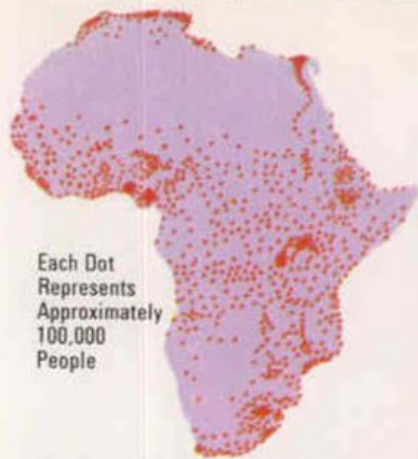


Below: The Greater Kudu, one of the many species of antelope which roam the African plains.



in Asia through the Red Sea and eastern Africa to Mozambique. It contains many lakes, including Lake Tanganyika, the world's longest freshwater lake. The rift valley was formed when the ground sank between *faults*, or breaks, in the Earth's crust.

Africa's largest lake is Lake Victoria, which lies between Kenya and Tanzania. Africa's greatest rivers are the Nile, the Congo, the Niger and the Zambezi.



Above: Population distribution map of Africa.

Right: The dense forests of lowland equatorial Africa contain many valuable hardwoods. Here huge logs are floated down a river.



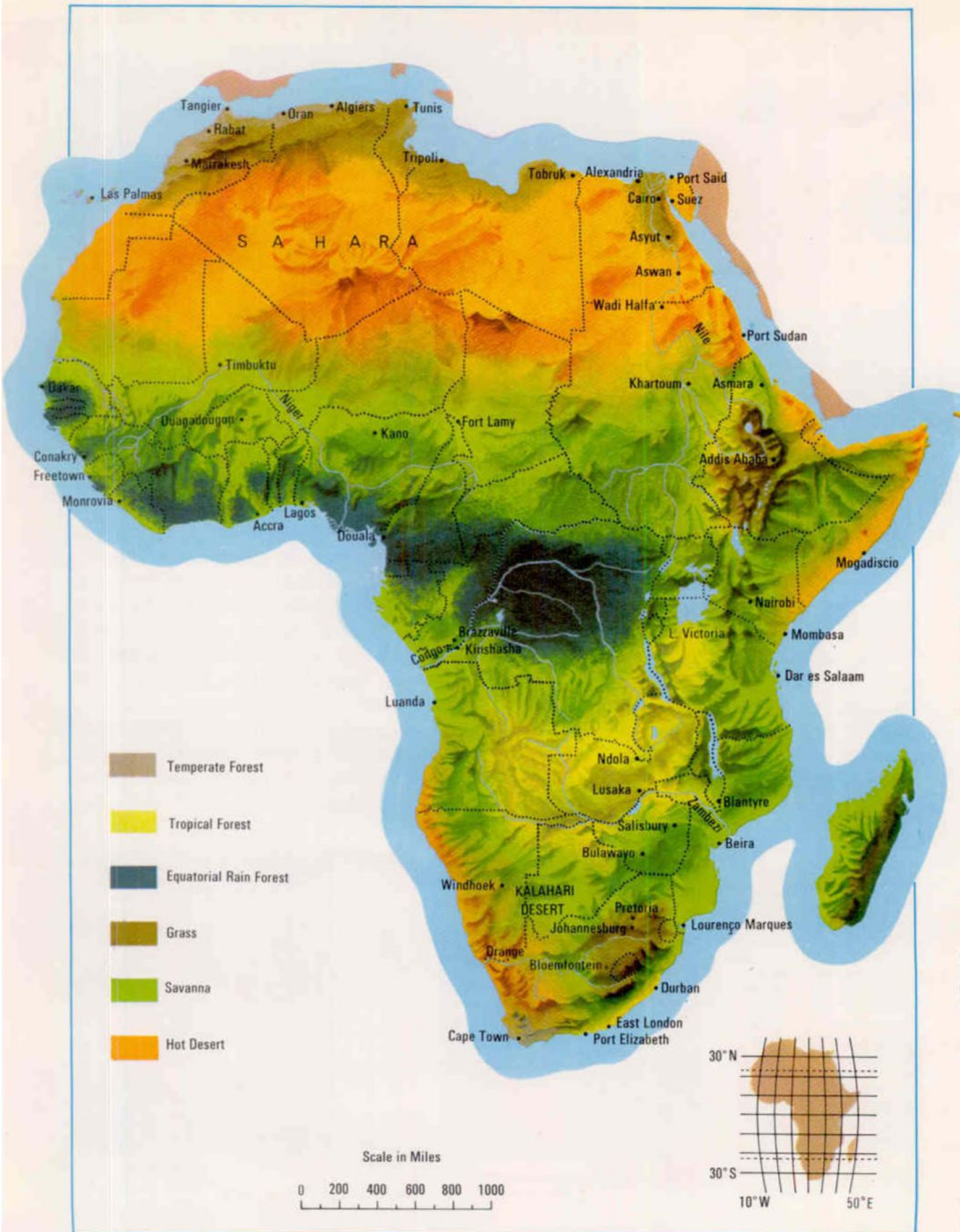
North of the Sahara, most of the people are Arabs or Berbers. They follow the Muslim religion. Negroid Africans, who make up three-quarters of Africa's population, live south of the Sahara. Some of them follow tribal religions. More than five million people of European ancestry live in Africa, many of them in South Africa. Their ancestors were the pioneers who introduced western ideas of farming, mining and industry. About half a million people of Asian origin also live in Africa. About 35,000,000 people, including most of the Europeans, are Christians.

Most Africans are farmers. They either rear cattle or grow crops to feed their families. The wealth of many African countries is based on one or two crops which are grown on plantations. For example, Ghana's most important export is cocoa. Eastern Africa's main products are coffee and sisal. Africa produces nearly three-quarters of the world's palm oil and palm kernels. Other crops include cotton, fruits, tea and tobacco.

Africa produces almost all the world's diamonds and a large quantity of gold. Other important minerals are copper, cobalt, petroleum and uranium. Africa has

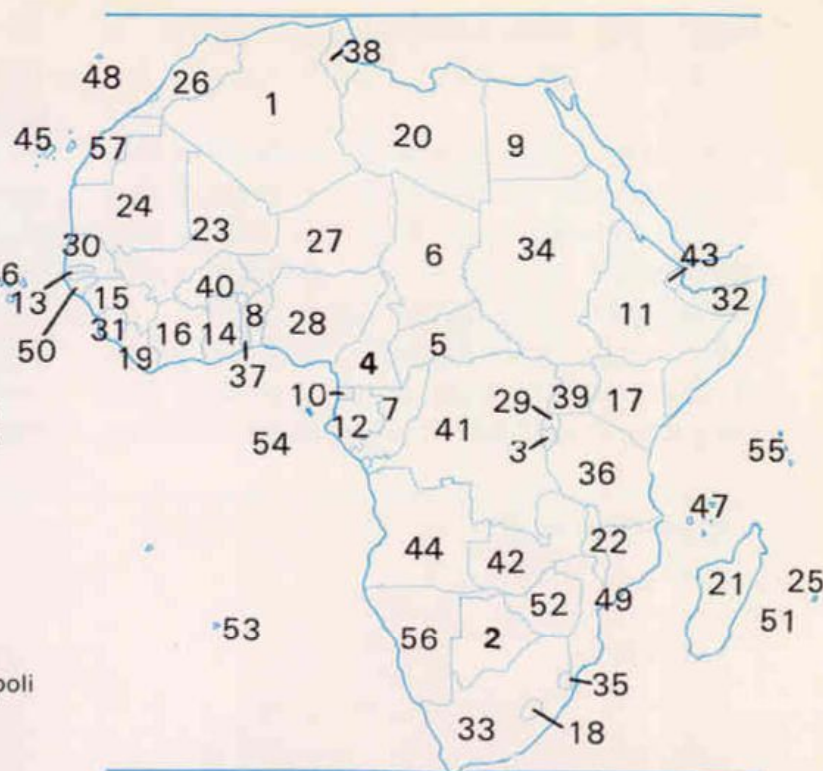
Right: In 1875 European interests in Africa were confined mainly to coastal settlements. But the following 25 years saw the 'scramble for Africa', with the European powers carving up the continent between them. These undeveloped lands provided a new market for the products of Europe's factories. Since the Second World War most of these former colonies have gained their independence.





INDEPENDENT COUNTRIES OF AFRICA

Country	Area (sq. mi.)	Population	Capital
Algeria	919,800	13,800,000	Algiers
Botswana	222,000	648,000	Gaborone
Burundi	10,747	3,600,000	Bujumbura
Cameroon	183,569	5,800,000	Yaoundé
Central African Rep.	236,294	1,500,000	Bangui
Chad	495,754	3,500,000	Fort-Lamy
Congo (Brazza- ville)	132,047	915,000	Brazzaville
Dahomey	43,483	2,700,000	Porto-Novo
Egypt (U.A.R.)	386,101	34,100,000	Cairo
Equatorial Guinea	10,832	300,000	Santa Isabel
Ethiopia	457,267	25,000,000	Addis Ababa
Gabon	103,089	485,000	Libreville
Gambia	4,003	357,000	Bathurst
Ghana	92,100	8,455,561	Accra
Guinea	94,926	3,890,000	Conakry
Ivory Coast	124,503	4,300,000	Abidjan
Kenya	224,960	10,900,000	Nairobi
Lesotho	11,716	1,000,000	Maseru
Liberia	43,000	1,200,000	Monrovia
Libya	679,360	1,900,000	Bengasi; Tripoli
Madagascar (Malagasy Rep.)	230,035	6,600,000	Tananarive
Malawi	46,066	4,530,000	Zomba
Mali	463,949	4,900,000	Bamako
Mauritania	419,230	1,200,000	Nouakchott
Mauritius	809	823,000	Port Louis
Morocco	172,413	15,525,000	Rabat; Tangier
Niger	489,190	3,800,000	Niamey
Nigeria	356,669	55,100,000	Lagos
Rwanda	10,169	3,600,000	Kigali
Senegal	75,750	4,050,000	Dakar
Sierra Leone	27,699	2,500,000	Freetown
Somalia	246,202	2,800,000	Mogadiscio
South Africa	471,466	21,447,000	Cape Town; Pretoria
Sudan	967,501	15,800,000	Khartoum
Swaziland	6,704	408,400	Mbabane
Tanzania	362,820	13,200,000	Dar es Salaam
Togo	21,853	1,954,916	Lomé
Tunisia	48,332	5,100,000	Tunis
Uganda	91,134	9,549,000	Kampala
Upper Volta	105,869	5,400,000	Ouagadougou
Zaire Rep.	905,565	17,400,000	Kinshasa
Zambia	288,130	4,300,000	Lusaka



Key to Independent Countries

1, Algeria; 2, Botswana; 3, Burundi; 4, Cameroon; 5, Central African Republic; 6, Chad; 7, Congo (Brazzaville); 8, Dahomey; 9, Egypt; 10, Equatorial Guinea; 11, Ethiopia; 12, Gabon; 13, Gambia; 14, Ghana; 15, Guinea; 16, Ivory Coast; 17, Kenya; 18, Lesotho; 19, Liberia; 20, Libya; 21, Madagascar (Malagasy Republic); 22, Malawi; 23, Mali; 24, Mauritania; 25, Mauritius; 26, Morocco; 27, Niger; 28, Nigeria; 29, Rwanda; 30, Senegal; 31, Sierra Leone; 32, Somalia; 33, South Africa; 34, Sudan; 35, Swaziland; 36, Tanzania; 37, Togo; 38, Tunisia; 39, Uganda; 40, Upper Volta; 41, Zaire; 42, Zambia.

Key to Colonies and Territories

43, Afars and Issas; 44, Angola; 45, Canary Islands; 46, Cape Verde Islands; 47, Comoro Islands; 48, Madeira Islands; 49, Mozambique; 50, Portuguese Guinea; 51, Réunion; 52, Rhodesia; 53, St. Helena; 54, São Tomé and Príncipe; 55, Seychelles Islands; 56, South West Africa; 57, Spanish Sahara.

AFRICAN COLONIES AND TERRITORIES

Name	Area (sq. mi.)	Population	Capital	Status
Afars and Issas	8,494	81,000	Djibouti	French colony
Angola	481,352	5,362,000	Luanda	Portuguese province
Canary Islands	2,808	908,718	Santa Cruz de Tenerife; Las Palmas	Spanish province
Cape Verde Islands	1,557	250,000	Praia	Portuguese province
Comoro Islands	838	270,000	Dzaoudzi	French colony
Madeira Islands	308	269,769	Funchal	Portuguese district
Mozambique	302,329	6,529,000	Lourenço Marques	Portuguese province
Portuguese Guinea	13,948	530,000	Bissau	Portuguese province
Réunion	969	436,000	Saint Denis	French department
Rhodesia	150,333	5,400,000	Salisbury	British colony*
Saint Helena	47	5,000	Jamestown	British colony
São Tomé & Príncipe	372	66,000	São Tomé	Portuguese province
Seychelles Islands	156	51,000	Victoria	British colony
South West Africa	318,261	615,000	Windhoek	South African mandate
Spanish Sahara	102,703	63,000	Alún	Spanish province

* Rhodesia declared its independence in 1965, but Britain did not recognize this act.

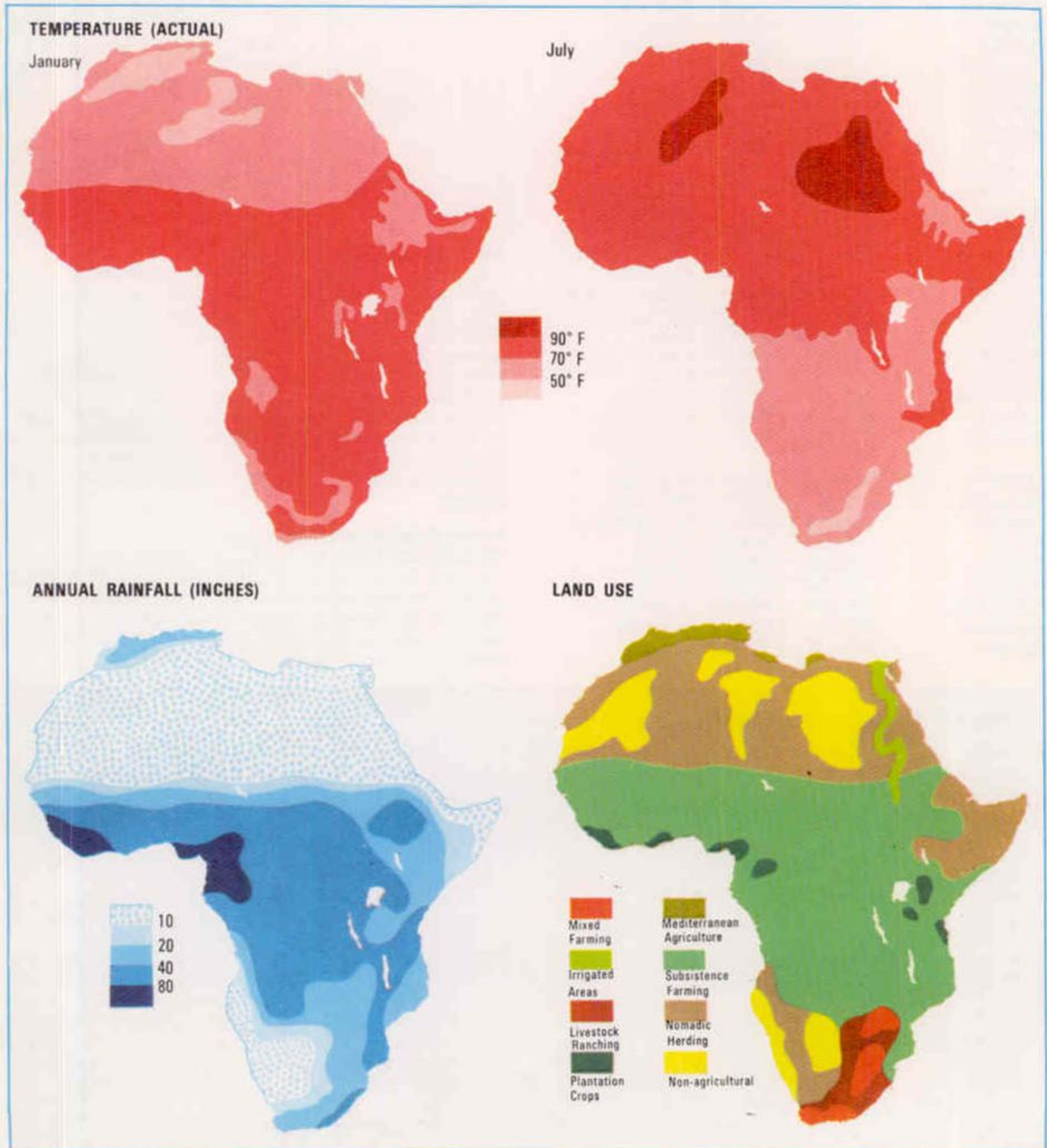
little coal, but hydro-electric power is used by the few manufacturing industries.

Northern Africa was important in the early growth of civilizations around the Mediterranean Sea. The Nile valley was the centre of one of the greatest early civilizations. (See Egypt, Ancient.)

But little was known of Africa south of the Sahara. Arab traders visited the area and found great empires in western

Africa. But to Europeans, Africa was a 'dark' continent. After Vasco da Gama had sailed to Asia around the southern tip of Africa in 1497, many ships used this route. Soon the African coastline was charted. But few people were interested in exploring the interior.

From the 1400's, European sailors began to ship slaves from Africa. The slave trade continued until the 1800's. An estimated 14 million African slaves were



shipped to the Americas. Usually the slave traders bought slaves from African coastal chiefs whose people raided inland tribes. European traders seldom travelled inland.

An early and important settlement at the Cape of Good Hope was established in 1652. This settlement developed to form part of present-day South Africa.

The great period of European exploration of the interior came during the 1800's. Many explorers were missionaries who helped to stamp out the terrible slave trade. Bold men, such as David Livingstone in southern Africa, Mungo Park in western Africa and Henry Morton Stanley in the Congo region, braved many hardships to discover the secrets of Africa. (See Exploration.)

Information brought back by explorers interested European governments, who began to establish settlements and colonies. By the 1890's, almost all of Africa was divided up between the European powers.

From the 1890's to the 1950's, most African countries were European colonies. The Europeans introduced new ways of life and developed Africa. But many Africans resented foreign rule. In the late 1950's and early 1960's, nearly all African countries achieved independence. By the early 1970's, the only large areas still governed directly by a European nation were Angola and Mozambique in southern Africa, which were ruled as provinces of Portugal.

Most of the independent nations of Africa are underdeveloped and their people have a low standard of living. These countries face many economic problems as they seek to raise living standards. Partly as a result of their poverty, many countries were unstable during the 1960's, and army leaders overthrew several elected governments.

Several large African countries contain many tribal groups, languages, and religions. Some of these countries have found it difficult to unite their people into one

nation. As a result, they have suffered from great internal problems. For example, civil war broke out in Congo (now Zaire) soon after the country became independent in 1960.

Another horrifying civil war took place in Nigeria where the people of the eastern province broke away and set up their own country, Biafra. This war, which lasted from 1967 to 1970, ended in the collapse of Biafra. It caused great suffering, hardship, and loss of life. In 1972 the government of Uganda ordered Asians living in the country to leave.

Talking points

* Why are many of the newly independent African countries so unsettled? Consider poverty, tribal mixtures, old colonial boundaries etc.

* Why was Africa one of the last continents to be explored by Europeans?

* How has the Kariba Dam

affected the lives of people, and the wildlife and vegetation of surrounding lands?

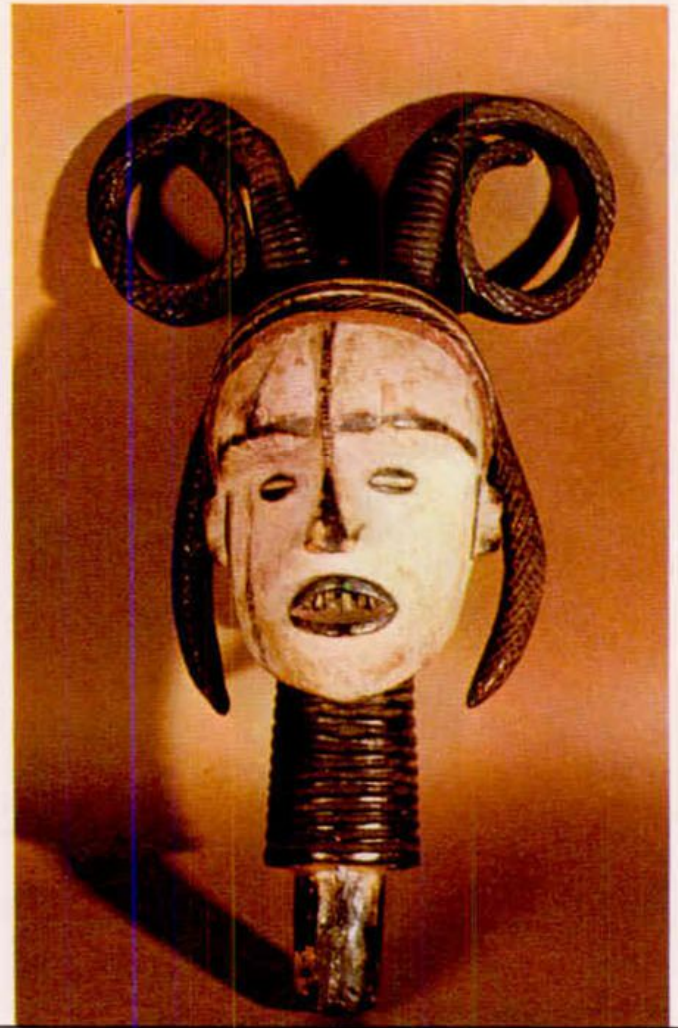
Articles to read

See under the names of separate countries. Also: African art; Dams; Deserts; Nile; Congo; Zambesi; Exploration.

African Art Traditional African art is often unusual and abstract. For example, sculptures of human figures often have large heads out of proportion to the rest of the body.

To understand African art, one must remember that most of it was made for a special religious purpose. The artists were not concerned with beauty in the European sense. Most of the finest traditional African art comes from western and central Africa. There, African tribal religions are still widespread despite the influence of Islam and Christianity. Most of the African religions are highly involved but they are based on a belief in one all-powerful God and in ancestor worship. The artists never represented God in their work. Instead they made statues and carvings of ancestors. The artists' job was not to make a realistic statue, but to give the final work a *life*

African art has had a considerable influence on western art. For example, the artist Pablo Picasso was greatly inspired by African masks and sculptures. The shapes used by African artists partly inspired the development of cubism and other forms of abstract art.



Most African art was made for religious purposes. The usually abstract sculptures of human beings and the symbolic masks often represented ancestors. Right, opposite: An Ibo piece of pottery used in the Yam festival. Left, opposite: Figures of this kind were placed in fields to increase and protect crops. Right: An Idoma dance headdress. Above: A Benin mask made of ivory. Benin is in modern Nigeria.

force that came from God. If the artists were successful, the spirits of the ancestors would then occupy the statues. Another common African art form is the mask. This was also made for religious purposes and after use it was destroyed. This is one of the reasons why so little African art of ancient times has survived. Another reason concerns the materials used by artists. Clay and wood were common, but clay objects are easily smashed and wood is eaten by the African ants.

Probably the best known early African sculpture comes from what is now Nigeria. Much of this art is not typical of African art generally, largely because it is so lifelike. The earliest known African sculpture was found near the village of Nok, in Nigeria. Nok sculptors made some beauti-

ful *terracotta* (hardened clay) and stone objects in about 250 B.C. Between the A.D. 1100's and 1300's, another Nigerian civilization called Ife flourished. Some Ife sculptures in bronze and terracotta are both beautiful and lifelike. The Benin civilization of Nigeria followed the Ife. Much Benin art has been discovered and the bronzes of kings, warriors and hunters, together with ivory statues of animals, are highly treasured today.

Ageing When animals grow old, noticeable changes take place in their appearance and the way they function. For instance, in man the skin becomes wrinkled and the hair grey. A person's memory becomes poor and he cannot use his limbs so well. This happens in all *warm-blooded*



animals and birds. They lose their vigour and *adaptability*.

As they get older, most creatures are less able to adapt themselves to changes and influences in their surroundings. They are no longer able to cope with certain unfavourable conditions, so that they become more prone to diseases and disabilities, particularly to the effects of non-infectious diseases. Excessive cold and damp, or too little food, leave an old animal more vulnerable than a younger one. At the same time, as these effects take place, the creature can take less exercise.

Among the mammals there seems to be some link between size and *life span* (length of life). Smaller animals age more quickly. Elephants are known to live for

up to 70 years, horses up to 40 years, cows 30 years, dogs 20 years, mice only about 4 years. These are maximum ages. Even more important seems to be brain size. Man, who has—in relation to body size—the biggest brain of all mammals, commonly outlives the elephant.

Birds generally have even longer natural life spans than mammals of-equal size. Parrots and eagles, for instance, can probably live for over 100 years. Cold-blooded amphibians and reptiles live even longer, in relation to size. Frogs and toads can pass the age of 20, while giant tortoises may live nearly 200 years.

Air is the mixture of gases that we breathe. It surrounds the Earth to a height of about 300 miles. It is often called the

atmosphere. Nearly four-fifths of the air is made up of nitrogen (78%) and more than a fifth is oxygen (21%). Most of the remainder is argon (0.9%). There are small amounts of many other gases in the air, including hydrogen, helium, neon, and carbon dioxide.

Air-conditioning is a method for controlling the quality of air in buildings, rooms, and cars. It controls the *humidity* (dampness) and temperature of air. It also cleans the air of harmful substances, such as soot, dust and pollen, and keeps the air circulating to prevent staleness. Air-conditioning systems are adjusted to provide a balance of temperature and humidity that is comfortable and healthy. In hospitals and public places, air may also be *sterilized* (made germ-free).

Air-conditioners take air from outside a building, or a vehicle, and treat it for use inside. They cool and dry the hot humid air that often occurs in summer. They may also warm and add moisture to the cold dry air of a bitter winter. In summer, air passing through the air-conditioner is cooled by a spray of cold water or by a refrigeration system like that used in a refrigerator (see Refrigerator). Cold air can hold less moisture than hot air, and if the hot air is humid, some of its moisture condenses as it cools. The air produced is cool and dry.

Aircraft Man has long envied birds for their ability to fly freely through the air. At first, men tried to fly by attaching artificial wings to their arms and flapping them. But their muscles were not strong enough for the task.

It was the English scientist Sir George Cayley who first proposed in the early 1800's that a flying machine should be designed as a bird with fixed wings.

In 1903, two American brothers, Wilbur and Orville Wright, built a flimsy machine of wood, cloth and wire which was powered by a petrol engine. On December 17, Orville made the first powered

flight on a deserted beach at Kitty Hawk, North Carolina.

After the Wrights had given demonstrations in Europe in 1908, aircraft development was rapid. In 1909, Louis Bleriot flew the English Channel. Aircraft were used widely in the First World War (1914-18), first for reconnaissance and then for fighting. Machine-guns were mounted in the nose, and bombs were dropped by hand. Most aircraft were biplanes—they had two wings, one above the other.

By the 1930's, aircraft were made of metal rather than of wood and fabric. They were streamlined, with retractable undercarriages, and had enclosed cabins. In 1936, the most successful commercial aircraft ever built—the Douglas DC-3, or Dakota—went into service.

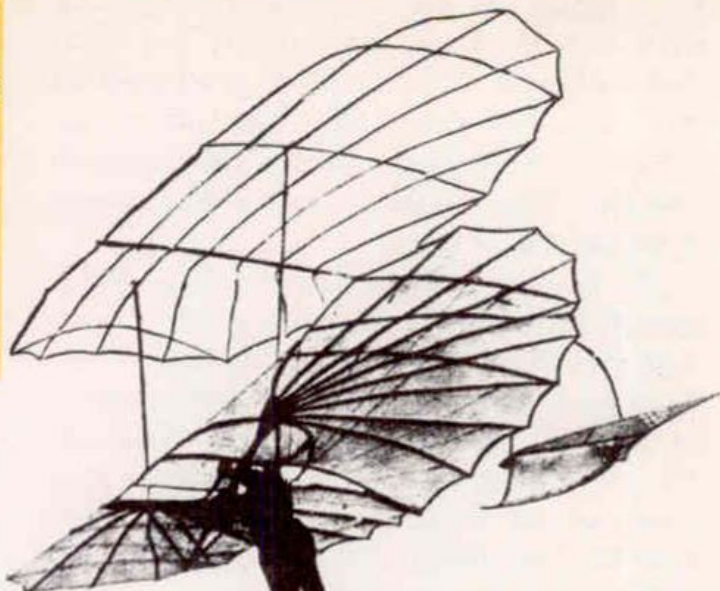
High-speed fighter aircraft such as the Spitfire and heavy bombers such as the Flying Fortress played a vital role in the Second World War (1939-45). By the end of the war, both the Germans and the British had developed jet aircraft. In 1947, a rocket-powered aircraft, the American Bell XS-1, flew faster than the speed of sound. In 1952, the first jet airliner—the British Comet—went into regular service. Today, fighter aircraft which travel at more than twice the speed of sound serve in the world's air forces.

To be able to fly, an aircraft must in some way lift itself off the ground against the Earth's gravity. This lift is produced by the movement of air over the aircraft's wings. The wings have a special cross-sectional shape, called an *aerofoil*, to produce lift. The aerofoil is sharply curved at the top and fairly flat at the bottom.

Air passing over the top surface travels faster than the air beneath because it

In 1919, John Alcock and Arthur Whitten-Brown made the first Atlantic crossing in a converted Vickers Vimy bomber. Charles Lindbergh made the first solo crossing in Spirit of St. Louis in 1927.

One of the great pioneers of heavier-than-air flight was the German engineer Otto Lilienthal who made more than 2,000 successful glider flights. His first glider was built of canvas, willow and bamboo, braced with strong wires, and he took off by running down a slope. Most of Lilienthal's gliders were monoplanes, but one was a biplane. He controlled them by swinging his legs and shifting the weight of his body. Lilienthal was killed while flying a glider in 1896. Seven years later the Wright brothers made the first powered flight in a heavier-than-air machine. Since that historic moment there has been a rapid development in aircraft design, and the advent of the jet-liner has revolutionised long-distance travel.



The Cavalcade of Flight



The Wright Brothers' Biplane



The Bleriot 8 bis



Douglas Dakota (DC3 Airliner)



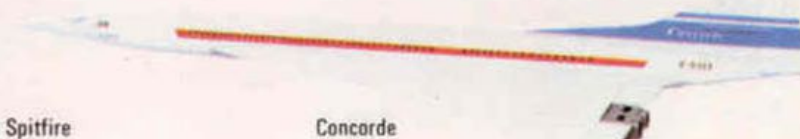
Handley Page O/400 S



Vickers Supermarine Spitfire



Super Fortress



Concorde

has farther to go. This means that the air pressure above the wing is less than that below it. The suction produced in this way lifts the wing. The lift is increased by angling the wing upwards slightly. This angle is called the angle of incidence.

The *thrust*, or force, needed to push the aircraft through the air, comes either from a propeller, or from a jet exhaust. When air passes over a propeller, or through a jet engine, its speed increases. That is, the air coming towards the engine is at a lower speed than the air rushing away from it. This difference in air speeds results in the forward thrust. With jet engines, the air leaving the engine is mixed with large volumes of hot gases from fuel burned in the engine. These add to the thrust. The thrust from a jet remains much the same at all speeds; that of a propeller engine decreases at high speeds.

This thrust is always opposed by the resistance, or *drag*, of the air on the aircraft body. Drag is reduced by building a smooth, streamlined body. For high-speed flight the wings are swept back from the body to reduce drag.

Most aircraft today are powered by jet engines. But some are still driven by propellers powered by piston engines using petrol. These engines work in much the same way as automobile engines but have different cylinder arrangements and may be air-cooled.

Jet engines produce much more power than piston engines of the same weight. They use a cheaper fuel (kerosene), too, but burn it at an enormous rate—1,000 gallons an hour or more. The most widely used jet engine is the *turbo-jet*. Air is sucked in and compressed by a special kind of fan called a *compressor*. The compressed air is then forced into combustion chambers where it is mixed with fuel and burned. The hot gases produced escape at high speed from the engine's exhaust to produce thrust. Before the gases escape, they spin the blades on a turbine which drives the compressor. For this reason,

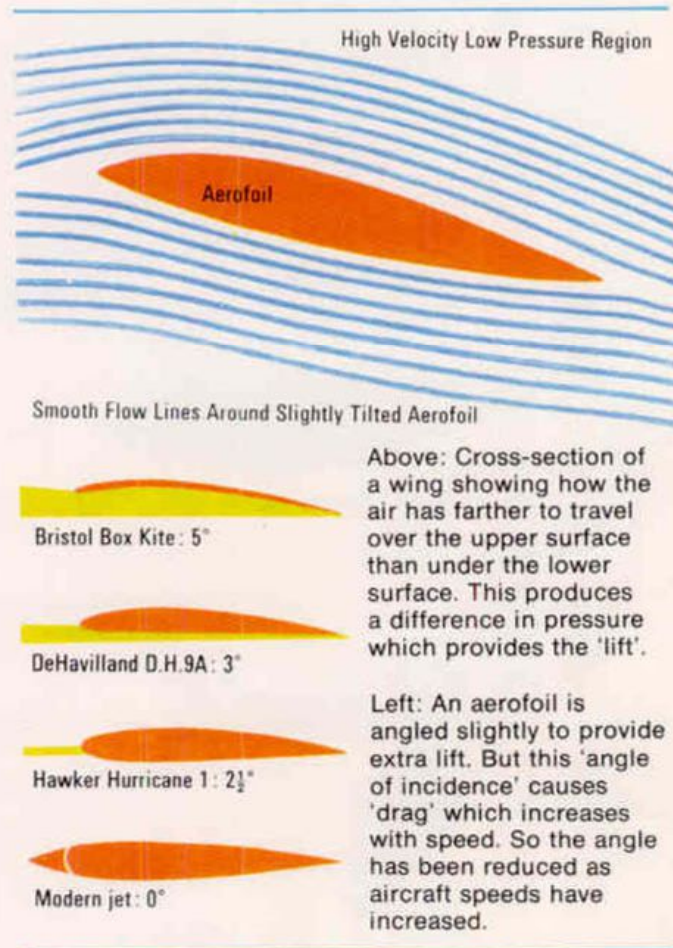
this engine is called a *gas turbine*.

The *turbo-prop* is similar in general design to the turbo-jet, but most of the thrust comes from a propeller driven by the turbine.

Later engines have two sets of compressors driven by two separate turbines. They are called *two-spool* engines. The *by-pass turbojet* engine is similar to the two-spool type but some of the air from the front compressor goes directly to the exhaust and makes the engine more efficient.

The *ram-jet* is the simplest jet of all, but works only at high speeds. It is basically a long tube through which air is forced. Fuel is sprayed into the air stream and burned.

The *pulse-jet* is similar, but it has valves which close the air intake while the fuel is burned. Burning is therefore not continuous but in 'pulses'. This was the engine used in the V-1 missiles used by the Germans to bomb London in the Second World War.



The main part of the aircraft body is the fuselage. At the front end is the cockpit, which houses the instruments and controls for the aircraft. Behind is the passenger cabin. In most aircraft, the fuselage is pressurized to make up for the decrease in air pressure when flying at high altitudes (30-40,000 feet).

The wings are attached to the fuselage. Sections of the trailing (rear) edges of the wings, called *ailerons*, are hinged. They can be moved up and down to cause the aircraft to tilt, or *bank*. Next to the ailerons are movable sections called *flaps*, which help to increase lift at low speeds and also act as air brakes.

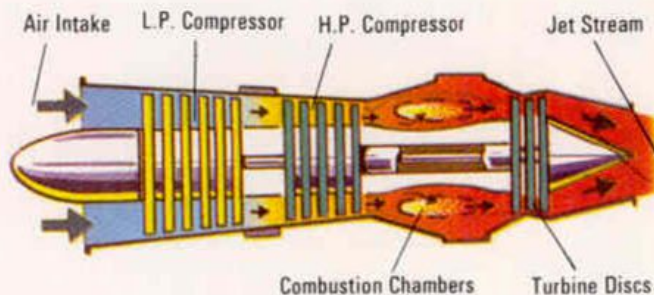
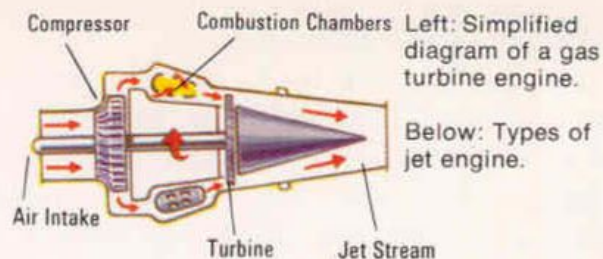
At the rear of the aircraft is the tail, which steadies the craft and helps to control its flight. Moving a rudder at the rear of the upright tail fin turns the aircraft to the left or right. Moving elevators at the rear of the horizontal tail plane control the up-and-down movement of the aircraft.

The pilot controls the aircraft from the cockpit. He has a steering wheel or column which he moves back and forth to control the elevators or from side to side to control the ailerons. He controls the rudder by foot pedals.

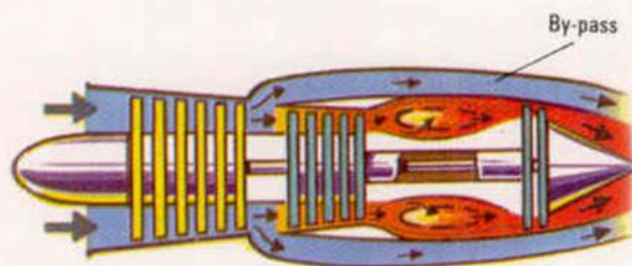
A wide variety of dials and warning lights in the cockpit keep the pilot informed about how the various systems in the aircraft are working, whether he is on course, and so on. The main flight instruments are an altimeter to show the altitude, an air-speed indicator, and a compass to indicate direction.

There are a variety of instruments for navigation, too. An automatic pilot keeps the aircraft on course when the pilot leaves the controls. The aircraft may also carry radar and other electronic equipment for making 'blind' landings.

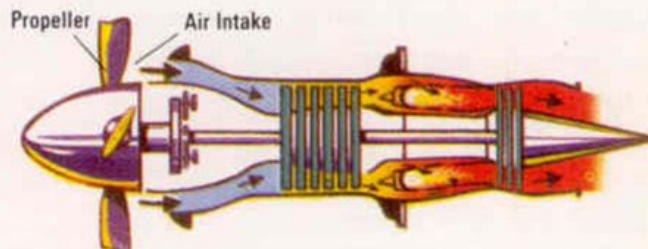
Planning, designing and testing a new aircraft takes many years. Designers test scale models of their aircraft in wind tunnels to find out how their aircraft will behave in real flight. They generally build full-size models, or 'mock-ups' of



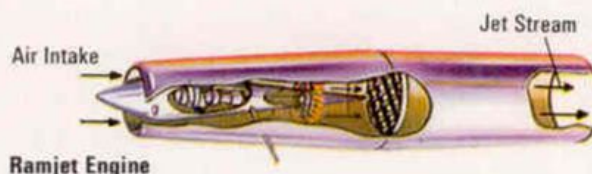
Two-spool or Supercharged Turbojet Engine



By-pass Turbojet Engine



Turboprop Engine



Ramjet Engine

wood to help them in detailed design and layout.

Engineers test full-size parts of the aircraft on test rigs or in pressure tanks under conditions similar to those found in flight to see whether the parts are strong enough. Many of the parts are twisted and stressed until they break. One of the great problems to overcome

is *metal fatigue*, which may occur after prolonged stress and vibration.

The first aircraft built, called a prototype, is tested thoroughly on the ground and in flight before production begins.

Light alloys are used for the metal skeleton of ribs and spars that form the framework of the aircraft. The surface skin over the skeleton is made up of thin alloy sheets joined together.

Talking points

* What effects do modern jet aircraft have on our environment?

* Compare the methods of powering aircraft, helicopters, and spacecraft.

* What are the main problems that air traffic controllers at large airports have to handle?

Articles to read

Airport; Astronautics; Balloons and airships; Gliding; Hovercraft and Hydrofoils.

Airport A large modern airport is a scene of intense activity both by day and by night. At peak periods, huge jet airliners, some weighing over 300 tons and carrying nearly 500 passengers, take off or land every minute or so. A large airport may handle 15 million passengers a year.

To deal with such vast amounts of traffic, every activity must be carefully co-ordinated. As soon as an aircraft has landed on the runway, it moves along a taxiway to an area called an *apron*. Immediately, trucks to carry baggage and buses to carry passengers hurry towards it. Then fuel tankers move in to refill the airliner's fuel tanks.

The most important people at the airport are the air-traffic controllers in the control tower, who supervise the landing and take-off of each aircraft. They bring down an aircraft from a height of five or six miles onto a runway about two miles long and 200 feet wide. Most airports have a criss-cross pattern of main runways so that aircraft can always land against the wind, which is much safer.

Aircraft contact the control tower as they approach the airport. If the runways are full, the controller tells the aircraft to circle one above the other until the runway is free. This is called *stacking*.

The ground controller uses a variety of instruments to bring the aircraft down



Upper picture: The cockpit of a modern airliner, showing the maze of instruments and controls.

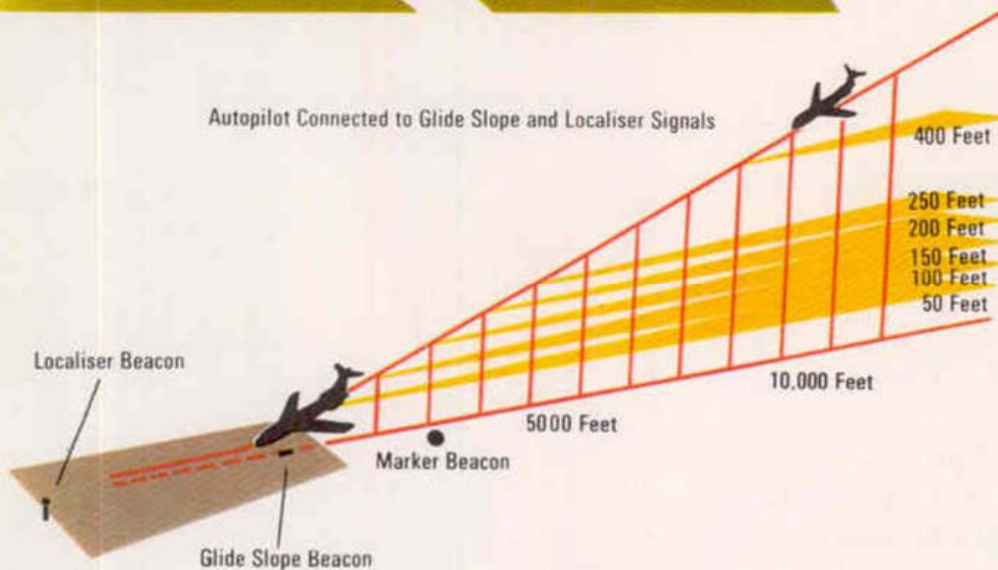
Lower picture: DC-9 jet aircraft on the production line.

safely in all kinds of weather. His main ones are radio and radar. His radar screen indicates the direction, distance and height of the aircraft.

Other electronic devices aid landing. The Instrument Landing System puts aircraft on the right flight path. The Automatic Landing System guides and lands the aircraft automatically.



Top left: Aircraft arriving at a busy airport may have to 'stack', that is fly at different levels awaiting their turn to land. When the runway is clear, the aircraft at the bottom of the stack is allowed to land and the rest move down one level.



Bottom left: In a blind-landing system an aircraft is automatically guided down onto the runway by a mechanical 'autopilot'. A localiser beacon tells the autopilot where the runway centre line is; a glide-slope beacon marks the correctly angled approach path; and a marker indicates the distance to the runway threshold.

Alabama is a state in the southern United States. Its name comes from the Indian word for people who clear thickets, and even today thick forests cover more than half the state. It has an area of 51,609 square miles; in the north are the Appalachian Mountains, while to the south lies the Gulf of Mexico. Much of the state is fertile farmland, and the chief crop is cotton. The population is 3,444,165. Montgomery is the state capital.

Alabama became part of the United States in 1819. During the Civil War (1861-1865) it joined the Confederacy (the Southern states). For many years parts of northern Alabama suffered from floods when the Tennessee River overflowed. The Tennessee Valley Authority was established in 1933 to control the river and today the TVA and other companies have made Alabama a leading source of hydroelectric power. Iron and steel production is the leading industry, and oil and coal are also important.



This location map shows the position of Alabama.

Alaska is the most northerly state of the United States. It is also the largest, with an area of 586,400 square miles. The Americans bought it from the Russians in 1867 for £7,200,000.

About one-third of Alaska lies north of the Arctic Circle. Snow and ice cover the land for much of the year. The people who live in this area include Eskimos, short, stocky people who live by hunting



Left: Location map of Alaska (marked in black), showing its position in North America.

Right: Trapping for furs is still an important activity in Alaska.



seals, fish and reindeer. Polar bears also roam northern Alaska.

The central and inland parts of Alaska contain a horseshoe-shaped range of mountains, high plains and thick forests. The 1,800-mile Yukon River flows through this region.

Running down the Pacific coast is a narrow strip of land known as the Panhandle. It has many *fjords*, steep-sided sea inlets, and thick forests. Its climate is mild, with plenty of rain.

Besides Eskimos, American Indians and Aleuts—people similar to the Eskimos—live in Alaska. But most of the 302,000 people are of European origin, living in Anchorage, the largest city, Juneau, the capital, and other cities.

Until recently, Alaska relied on few industries, such as fishing, especially salmon fishing, fur-trapping and lumbering. It also had coal, gold, and platinum mines. But the discovery of vast deposits of petroleum in Prudhoe Bay in 1969 has made petroleum Alaska's fastest growing industry.

The explorers Alexei Chirikov and Vitus Bering first reached Alaska from Russia in 1741, and the first permanent settlement was made by Russians on Kodiak Island in 1784. But the area was not developed much until 1899 when gold was discovered there. Though the 'gold rush' days have long since passed, Alaska is still very rich in mineral resources. In 1959 it became the 49th state of the United States.

Albania is a small, mountainous country in south-eastern Europe. It lies on the Adriatic Sea. Greece borders Albania to the south-east and Yugoslavia to the north and east. The Albanian Alps, which cover most of the country, make communications difficult.

Most Albanians live on farms or in isolated mountain villages. They are mainly Muslims, but some are Christians. Those on the coast fish. The farmers grow wheat, tobacco, maize and cotton,



Left: Location map of Albania (marked in black), showing its position in relation to Italy.

Facts and Figures

Area: 11,000 square miles.

Population: 2,200,000.

Capital: Tirana.

and raise cattle, sheep, pigs and goats. Albania's few industries include food processing and cloth making. Albania has large mineral deposits and petroleum is exported.

Albania was part of the Turkish Empire for 400 years and became independent in 1912. It has been a communist state since 1945 and now receives political and economic aid from communist China.

Albatross The albatross is a member of the petrel family. Petrels are also called *tube-noses*, because their nostrils open through tubes on top of the beak.

The albatross is an oceanic bird that often stays far out to sea for months on end. It is a wonderful flier. It soars easily over the waves, and comes ashore only to breed, or when driven there by storms. The wandering albatross has a wing span of 11 feet, the largest span of any living bird. There are 13 species of albatrosses and most of them live in the far south of the southern hemisphere.

Alberta is the westernmost of Canada's three prairie provinces. British Columbia borders Alberta to the west and the Northwest Territories lie to the north. Saskatchewan is to the east and Montana in the United States lies to the south. Alberta is known for its national parks, Banff and Jasper, the towering Rocky Mountains, and the Calgary Stampede, an annual rodeo. The province was named after Princess Louise Alberta, the daughter of Queen Victoria. Alberta has a population of 1,593,000. Most of the people have British, German, Ukrainian, or Scandinavian ancestors. There are also 29,000 Indians and Eskimos in Alberta. Over one half of the province's population lives in Edmonton, the capital city, or in Calgary.

The province covers an area of 255,285 square miles and is very rich in wheat, cattle, wood products, oil and natural gas. Alberta has grown quickly in population and industry. Just over a century

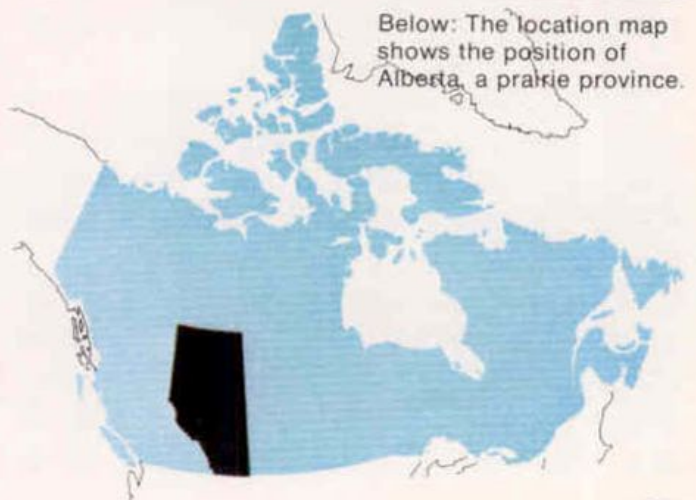
With its long wings the albatross can soar effortlessly over the sea.



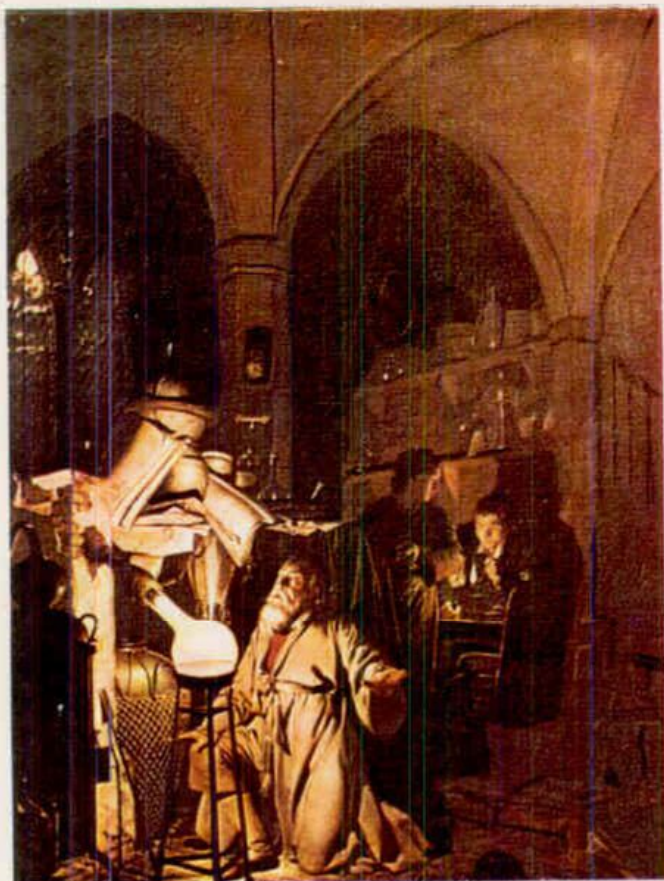
ago, Indians and buffalo roamed the country. Today wheat fields and large cattle ranches cover hundreds of square miles.

Alberta has a varied landscape. Rolling prairies cover the south. In the Red Deer Valley are the Badlands, where dinosaur fossils, the remains of giant prehistoric animals, have been found. Rolling plains rise to the foothills. Above these are the Rocky Mountains, with peaks rising to 12,000 feet. Among the mountains are national parks, game preserves, ice fields and mineral springs. There are many places to ride, fish, ski and camp. Each year about two million people visit Banff, the most famous national park. Northern Alberta is mostly covered by forest. Few people live there, and much of the region is unexplored.

Probably the first European to enter Alberta was Anthony Henday, in 1754. He worked for the Hudson's Bay Company, a fur trading organization. For the next 100 years, only trappers and traders lived in the region. However, in 1869



Below: The location map shows the position of Alberta, a prairie province.



A painting by Joseph Wright (1771) shows the German alchemist Hennig Brandt praying after his discovery in 1669 of a new element. His laboratory is lit by the glow of his discovery — phosphorus.

Canada bought the land from the Hudson's Bay Company. It was then called Rupert's Land. Renamed Alberta in 1882, it became a Canadian province in 1905.

Alchemy We know today that every substance is made up of a number of chemical elements in combination. Each element is different from every other element. And one element cannot be changed into another by normal chemical means. This picture of matter began slowly to emerge during the 1600's and 1700's.

Before then, most people believed that there were only four basic 'elements'—fire, air, water, and earth. The great Greek philosopher Aristotle first put forward this view in the 300's B.C. Every substance was believed to be made up of a different combination of these four elements. But the proportion of the elements could be altered by adding some of the other elements, which meant that

every substance could be changed into any other substance.

This led to a quest for methods of changing lead and other so-called 'base' metals into gold. People began to believe that there was a magical substance called the *philosopher's stone*, or *elixir*, which had the power to carry out this change.

The people who carried out experiments to make the philosopher's stone, with a mixture of science and magic, were called *alchemists*. They also considered that the philosopher's stone, or elixir, had the power to make human beings immortal. Small wonder then that alchemy was widely practised and attracted royalty, scholars and rogues alike. It became closely associated with astrology because of a belief that metals were linked with the heavenly bodies.

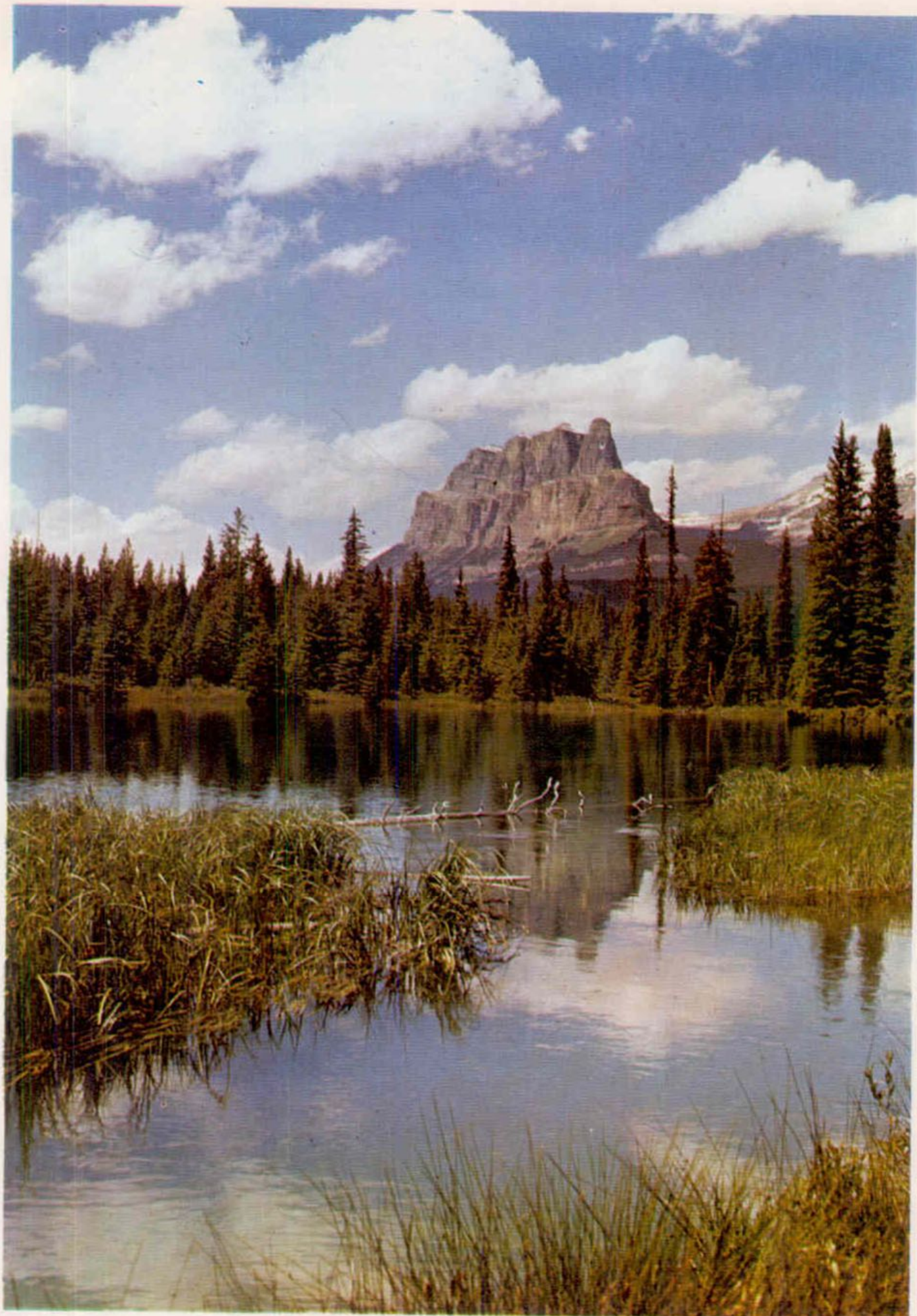
Of course, the alchemists had no luck in their quest. But it is from their methods, apparatus, observations, and accidental discoveries that the modern science of chemistry developed.

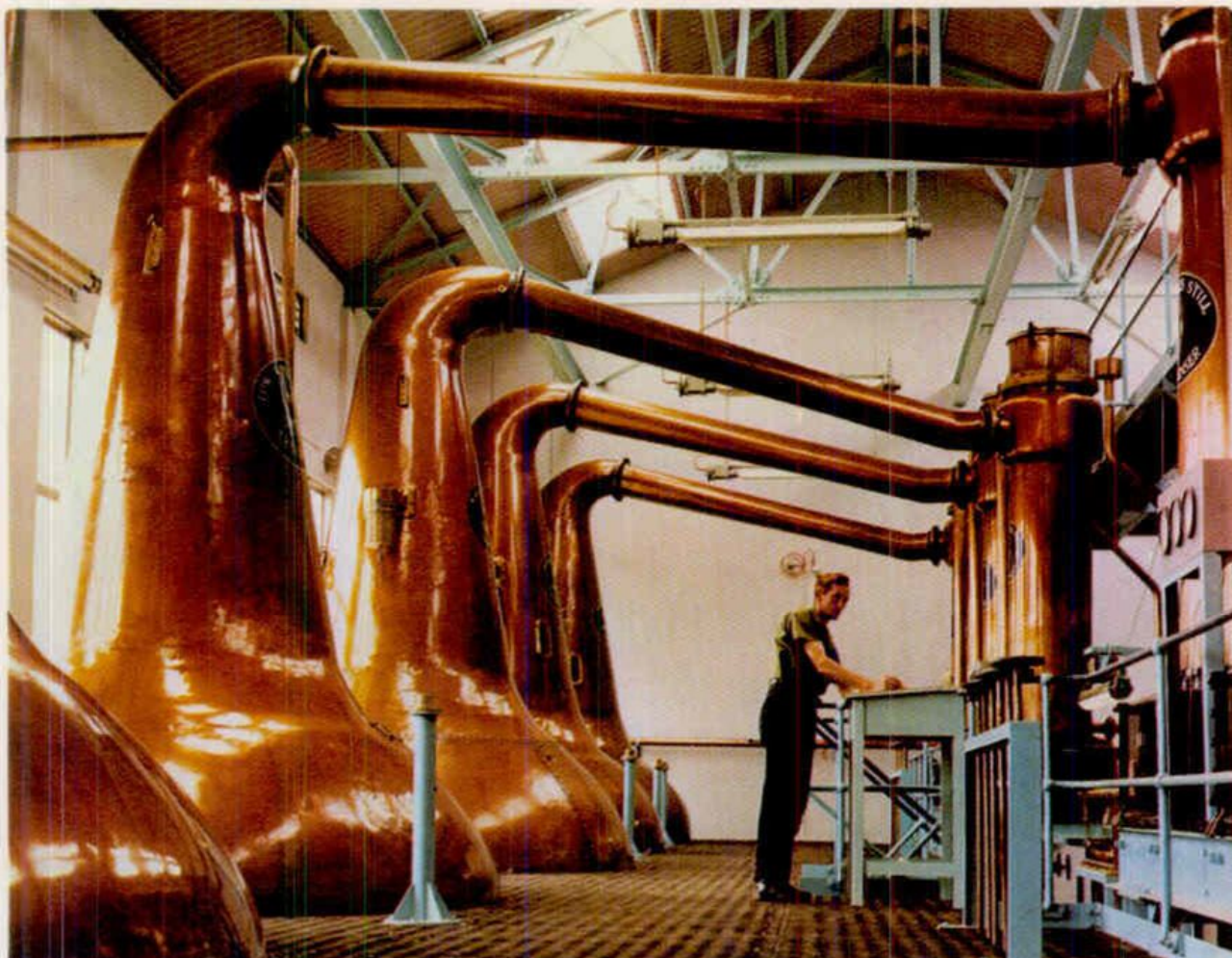
Alcohol If a person drinks too much beer or wine he becomes *intoxicated*. The intoxicating substance in these drinks is alcohol. It is formed by a process called *fermentation*, in which tiny organisms called *yeasts* act on natural sugars.

Wine, for example, is made from juice pressed from grapes. Yeasts from the grapes get into the juice and feed on the sugar it contains to produce alcohol and carbon dioxide gas, which bubbles off. Cider is made from apples in a similar way. Beer is produced by fermenting grain, usually barley.

When the alcohol reaches a certain level it kills the yeast and prevents further fermentation. To increase the amount of alcohol, the fermented liquid must be *distilled*. The alcohol boils away first and is condensed (turned back into

Right: Banff National Park, Alberta. Alberta is one of the 'Prairie Provinces', but in the south-west rise the Rocky Mountains.





Malt whisky is made from barley which is allowed to germinate then roasted above a peat fire and mashed with water. Yeast is added and the fermenting liquid is distilled in pear-shaped copper-stills. The alcohol vapour is led through water-cooled pipes where it condenses to liquid whisky.

liquid). The so-called 'spirits', such as whisky, brandy and gin are distilled.

Industrially, alcohol is often made from cereals and potatoes. It is widely used as a *solvent*, or dissolving substance, for many organic chemicals.

Alcohol is one of a group of chemicals called the alcohols. It is also called *ethanol* and *ethyl alcohol*. Other important alcohols include *methanol*, or *wood alcohol*, used in methylated spirits. *Ethylene glycol* is another alcohol, used for antifreeze.

Alexander the Great (356-323 B.C.) was a powerful ruler and a brilliant military leader. He conquered much of the civilized world, spreading Greek culture throughout his territories.

As a boy, Alexander was tutored by Aristotle, who taught him to love Greek literature and philosophy. He became king of Macedonia before he was 20, when his father was assassinated. The Greek states were restless under Macedonian rule, and began to revolt against the young king. Alexander stormed the city of Thebes, destroying nearly every building. The spirit of the rebellion was broken, and the Greek states joined together under Alexander.



Bust of Alexander the Great.

Having united Greece, Alexander launched a war on Persia. With 30,000 foot soldiers and 5,000 cavalry, he marched into Syria. Two years later it was his. He continued his march into Egypt. Weary of Persian rule, the Egyptians welcomed his coming. He founded the great city of Alexandria in Egypt. He defeated Darius, the Persian king, in the historical battle of Arbela. Babylon, Susa, and Persepolis, the richest and most beautiful cities of the time, opened their gates to welcome his coming.

Alexander died at Babylon, which he had made capital of his vast empire. At the height of his power, this empire reached from Greece to north-western India.

Alfalfa is a plant of the pea family that is cut, dried, and used as hay for feeding farm animals. It is also called *lucerne*. Alfalfa is rich in protein and mineral salts. It grows with fat green branches and bunches of purple flowers. Its long root sometimes grows down as deep as 30 feet through dry soil, enabling the plant to survive long dry periods.

Alfred the Great (849-899) was an English king. He became king of Wessex in 871. Most of the early years of his reign were spent fighting the Danes, who had invaded and captured the northern and eastern parts of what is now England. The Danes forced him to retreat into Somerset in 878. But before the end of the year Alfred returned and routed his enemies at Edington, in Wiltshire. By the treaty of Wedmore, the Danes were restricted to an area north of a line from Chester to London. The remainder was Alfred's kingdom of Wessex.

In the peace that followed, Alfred strengthened the navy, reformed the system of local government, supervised finance and local justice, and issued a code of laws. He also encouraged learning, and translated various Latin works into English.



Alfred the Great drove the Danes out of south-west England and made new laws for his kingdom of Wessex.

Algae are plants that grow in water or in damp places. The ones that grow on the sea-shore are called seaweeds. A visit to the sea-side tells you how numerous ocean forms are, while fresh-water forms often give rise to the green scum on ponds you see in the summer. Terrestrial forms—those that do not live in water—are not so common, but you may see one form growing as a green crusty coating on tree trunks—particularly on the tree's shaded side.

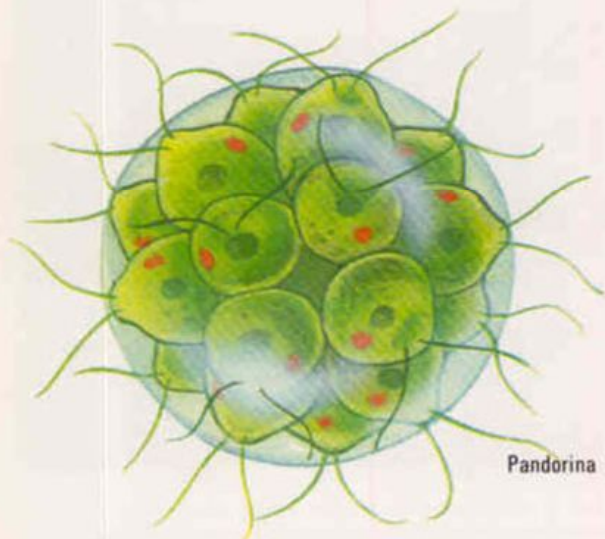
Algae contain some of the largest as well as the smallest kinds of life. In this enormous group of plants—about 17,000 species are known to man—many kinds consist of just one cell and can be seen only with a microscope. But certain brown seaweeds, called *kelps*, grow more than 50 yards long. Some single-celled forms are more like animals than plants, since they can move about. They have *flagella*—long hair-like out-growths of the body—that drive the organism



A Desmid



A Diatom



Pandorina

Algae range in size from microscopic single-celled forms to brown seaweeds 50 yards long.

Top left: A desmid and a diatom, two single-celled microscopic algae.

Bottom left: Pandorina, a microscopic colonial alga which consists of 16 identical cells arranged in a solid ball embedded in jelly. Each cell acts as an individual plant.



Red Seaweed

Top right: A leaf-like red seaweed.

Bottom right: A common brown seaweed.

Far right: Bladder wrack with a diagram showing the reproductive pits (conceptacles). Male and female cells are released from them and join together in the water to form new plants.



Channelled Wrack

through the water with whip-like lashing movements. Between single-celled forms and large seaweeds are several *colonial* algae, where groups of cells, each retaining a more or less separate way of life, combine and move about as one.

Algae are a vital link in the chain of life in the water. Single-celled forms, such as desmids and diatoms, make up floating 'soups' of microscopic organisms collectively called *plankton*. Plankton is a basic source of food for all animal life in the water, both in the sea and in fresh water.

Seaweeds provide protection for animal life by the sea-shore. Most seaweeds are covered in a slimy substance, called *mucilage*, which prevents them losing water and, at the same time, produces a conveniently moist shelter for marine animals when the tide goes out.

From a botanical point of view, algae are rather primitive. If you compare them with flowering plants, for example, you

find that algae have no proper stems, leaves, or roots, though certain seaweeds have a root-like structure known as a *holdfast*.

Algae do not have flowers. Instead of the pollen and egg cells of flowering plants, most algae release male and female sex cells of fairly similar size and shape into the water. Nearly all algae can also reproduce without sex cells. The contents of a cell divide into a number of 'units', and the cell then bursts open. Each 'unit' released is capable of developing into a new plant.

Most algae possess the green pigment chlorophyll, the substance that traps light energy and puts it to work to make sugars. A lot of algae do not look green, but this is because they contain other pigments besides chlorophyll, which mask the green colour.

Algeria is the second largest country in Africa. Situated in the north-west, its



coastline faces the Mediterranean Sea. Most Algerians are Arabs or Berbers who live in the most fertile northern part of the country. The centre and south are part of the waterless Sahara. The Atlas Mountains separate the fertile coastlands from the sun-baked desert.

Temperatures in the north sometimes reach 100° F (38° C) in summer. But they fall below freezing point in winter. Between 18 and 30 inches of rain fall every year in the north.

Less than a quarter of all Algerians live in towns or cities. Most of the others are farmers. Important exports include fruit, iron ore, phosphates and wine. Today petroleum and natural gas extracted from under the Sahara are also becoming important. The gas and oil are piped northwards to the coast and then shipped to Europe.

In the A.D. 600's, Arabs occupied Algeria, and in the 1500's it became part of the Turkish Empire. From 1830, many

French people settled in Algeria, which became a province of France. Algeria won its independence in 1962.

Alice Springs (pop. 6,001) is a town in the Northern Territory of Australia. Lying 950 miles south of Darwin and 1,000 miles north of Adelaide, it is close to the geographical centre of the continent. The town stands 1,900 feet up in the Macdonnell mountains, on the banks of the Todd River. It serves as a supply base for central Australia, and caters for prospectors, cattlemen, and tourists.

Alkalis Caustic soda and caustic potash are the best known of the chemicals called alkalis. They form a solution in water that is very bitter to the taste and feels slippery or soapy. And they are in fact used to make soaps—soda for hard soap, potash for soft soaps. Caustic soda is used in making paper and rayon, too.

The proper names for these alkalis are sodium hydroxide and potassium hydroxide. They are called *caustic* because they can burn and destroy body tissue.

Chemically, alkalis are strong bases—substances which combine with, or *neutralize*, acids to form salts (see Acids). One of the weaker alkalis is ammonium hydroxide, or common household ammonia.

All Blacks is the name given to the New Zealand national rugby union team. They are called All Blacks because they play



Location map of Algeria (marked in black), showing its position in Africa.

Facts and Figures

Area: 919,800 square miles.
Population: 13,800,000.
Capital: Algiers.

in black jerseys, shorts, and socks. On tour they open their matches with a Maori chant and dance called a *haka*.

Because rugby is so important to New Zealanders, it is regarded as a national disaster if the All Blacks lose. As a result, they play to win in a way that often seems ruthless and determined. They base their attack on strong, hard forwards. Since the early 1900's, the All Blacks have been one of the best rugby teams in the world.

Allergy is abnormal sensitivity to a substance that most people find harmless. For example, some people are allergic to feathers or to milk, and if they come into contact with these substances develop ailments such as skin rashes, inflammation of the eyes, or indigestion. A common allergy is hay fever, which is usually caused by sensitivity to certain kinds of pollen. Some cases of asthma are allergies. A substance that causes an allergy is called an *allergen*.

Scientists do not fully understand how allergies develop. But many believe that they result from the over-production in the body of a substance called *histamine*. This substance is produced by a reaction between the allergen and proteins called *antibodies*.

Alloys Few pure metals have all the properties we require of a metal. But we can usually improve the properties of a pure metal by adding other metals to it to form a mixture called an *alloy*. For example, copper is soft and fairly weak but we can add zinc to it to form brass, or tin to form bronze, both of which are hard and strong. Aluminium, too, can be greatly strengthened by adding copper to it. In fact, most alloys are stronger than the parent metals.

Steel, the best-known alloy, consists of a mixture of a metal—iron—not with another metal but with the non-metal carbon. Other metals are added to steel to produce the most important of all alloys—the alloy steels.

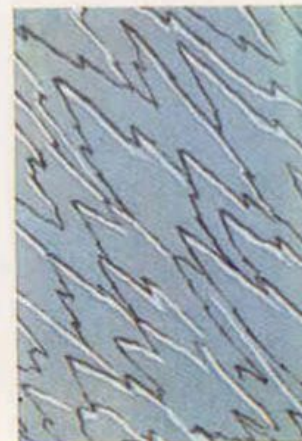
Metals for alloying are chosen and mixed so that the alloy has the combined best properties of both metals. Stainless steel, for example, has the strength of steel and is stainless like the chromium it contains. By themselves, steel will rust and chromium is not strong.

The properties of alloys can usually be further improved by methods of heat treatment, such as annealing (heating and cooling slowly) and quenching (heating and dipping in cold water or oil).

Alphabet This is a group of characters or symbols used to write down a language. English is written in the *Roman* alphabet with 26 letters. Most other European languages are written in this alphabet, but the actual characters or letters may be pronounced in different ways. The 26-letter alphabet is not large enough for some of these languages, and accent marks are added to the letters to show differences in pronunciation. In French, accented letters include *é*, *è*, *à* and *ç*; and in German *ü* and *ö*. Additional letters may be



Metals mix in different ways. They may remain quite separate in the alloy, with crystals of one embedded in crystals of the other (top left). They may mix slightly, so that the crystals of one metal contain traces of the other metal (top right). Or they may dissolve in each other completely (bottom right).



Wun ðæ a dog felt very pleesd with himself becaus hee had a luvly, big, juesy pees ov meet, and hee desieded tō tæk it tō a plæs whær hee cōd enjoi it. On the wæ hee crosst a streem bie a narrœ bridʒ and pausd tō lōk in the wauter. tō his disgust hee sau thær a dog liek himself with an eeven bigger and nieser pees ov meet. sœ hee droppt his æn meet and pounst on the uthær dog's meet, and found himself floundering in the streem with nœ meet at aull.

used, such as the German *ß* (which stands for *ss*) and the Danish *ø*. Some languages use a Roman alphabet of less than 26 letters. Serbo-Croat dispenses with *q*, *w*, *x* and *y*; the Hawaiian language uses only 12 letters.

There are several other alphabets in common use. The *Greek* alphabet has 24 letters. It is used only in Greece, although scientists use the letters as symbols in their work. The word 'alphabet' comes from its first two letters: A (*alpha*) and B (*beta*). Russians and other Slavs use the *Cyrillic* alphabet, which was developed from Greek about 1,100 years ago. Gaelic is written with an alphabet of 18 letters derived from the Roman alphabet. All these alphabets contain symbols for vowels and consonants. But the Arabic and Hebrew alphabets have symbols for consonants only. Vowels are indicated only by accent marks, and often never used at all.

Some languages can be written in two alphabets. Serbo-Croat is written in the Roman alphabet in one part of Yugoslavia and in the Cyrillic alphabet in another. And alphabets have been changed. In 1928, the Turks changed from using the Arabic alphabet to a Roman alphabet. New phonetic alphabets have now been designed to help children learn to read.

Above: An example of the Initial Teaching Alphabet which has been designed to teach children to read.
Below: A comparison of the characters in the Arabic, Hebrew, Greek, Cyrillic and Latin alphabets.

Arabic	Hebrew	Greek	Cyrillic (Russian)	Latin
ا	א	α	а	A
ب	ב	β	б	B
س, ك	כ, ס	κ, σ	к, с	C
د	ד	δ	д	D
ی	י	ε, η	е, э	E
ف	פ	φ	ф, ө	F
گ	ג	γ	г	G
ح	ה	ι	г	H
ی	י	ι	и, й	I
ج	—	—	дж	J
و	ו	κ	к	K
ل	ל	λ	л	L
م	מ	μ	м	M
ن	נ	ν	н	N
و	ו	ο, ω	о	O
پ	פ	π	п	P
ق	ק	ρ	—	Q
ر	ר	ρ	р	R
س	ש, ס	σ, ς	с	S
ط, ث	ת, ט	τ	т	T
ز	ז	υ	ы, ю	U
و	ו	υ	в	V
و	ו	φ	—	VV
—	—	ξ	кс	X
ی	י	ι, υ	я	Y
ظ, ذ	ז, צ	ζ	з	Z

Talking points

* The English language is pronounced very differently in the many countries in which it is spoken. Could a phonetic alphabet really make reading English easier?

* What would be the advantages if exactly the same alphabet were used for every language?

* Write a history of our alphabet, showing how it developed from Egyptian hieroglyphs. Illustrate it with different types of writing including Roman, Gothic, and copperplate.

Articles to read

Hieroglyphics; Printing; Writing.

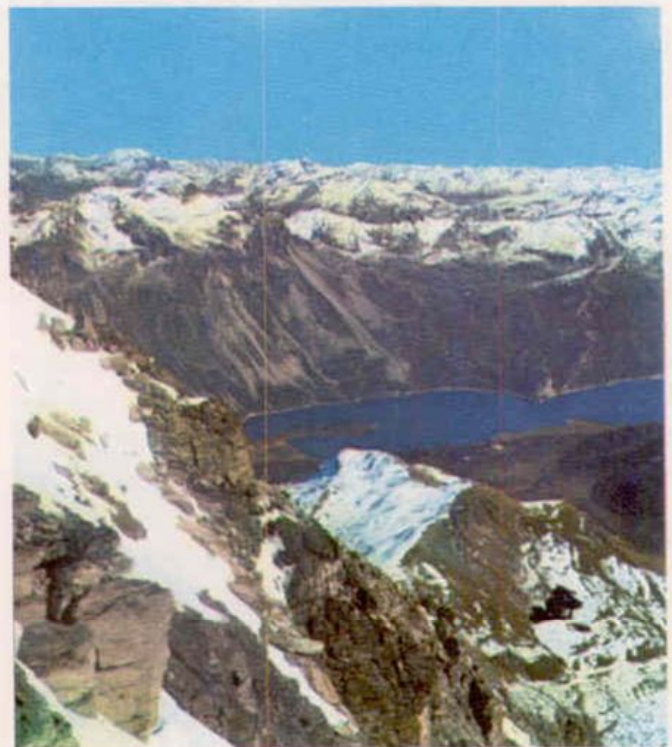


Alps The Alps are the greatest mountain system in Europe. They form an arc stretching for 680 miles from the Mediterranean in the west to the Adriatic in the east. They are between 80 and 140 miles wide and cover some 80,000 square miles. Their average height is 6,000 to 8,000 feet above sea level, but many peaks soar well above 10,000 feet.

Starting in France, by the Mediterranean, the Alps curve northwards, forming the border between France and Italy. They form the northern barrier to Italy and continue eastwards through Switzerland, southern Germany, and Austria. Finally, they turn southwards into Yugoslavia.

The main ranges are divided into Western, Central, and Eastern Alps. The *Western Alps* are those lying west of the Great St. Bernard Pass. The *Central Alps* are those between the Great St. Bernard Pass and Lake Constance. The *Eastern Alps* lie to the east of Lake Constance.

Alpine peaks, although not high by Asian and American standards, have presented formidable challenges to mountaineers. Mont Blanc (15,781 ft) is the highest mountain in Europe. Other well-known peaks are Monte Rosa (15,217 ft) and the Matterhorn (14,685 ft). The Eiger



The Alpine scenery, together with its opportunities for climbing and winter sports, attracts many tourists. The Alps have been called the 'playground of Europe'.

(13,042 ft) has an almost vertical rock wall for more than 7,000 feet.

Well-known Alpine tunnels and passes include the Little St. Bernard (a pass between France and Italy), the Great St. Bernard, St. Gotthard and Simplon (passes between Switzerland and Italy), and the Brenner Pass (between Austria

and Italy). Two of the most recent road tunnels are the Mont Blanc, between France and Italy, and the Great St. Bernard tunnel, between Switzerland and Italy.

The Alps support a thriving tourist industry. Some of the best-known resorts where people go for winter and summer sports are Davos, Zermatt and St. Moritz in Switzerland; Innsbruck and St. Anton in Austria; Chamonix in France; and Cortina and Bolzano in Italy.

Aluminium In the early 1800's aluminium was virtually unknown and was regarded as a precious metal much dearer than gold. But it has now become one of our commonest and most useful metals.

Aluminium's most outstanding property is its lightness. It is only one-third as heavy as steel. And some of its alloys with copper and magnesium are as strong as steel. Aluminium and its alloys are therefore especially useful where lightness and strength are important, such as in aircraft, vehicles and ships. In addition, aluminium does not rust like steel, and it can be easily shaped.

Aluminium and its alloys are used for cooking vessels because they conduct heat well. They also conduct electricity well and are used for overhead power cables.

There is more aluminium in the Earth's crust than any other metal. But the only suitable ore is bauxite, which contains alumina—aluminium oxide. The metal is obtained by passing electricity through a solution of alumina in molten cryolite.

Amazon is the greatest river in South America. It is the second longest river in the world (only the Nile is longer), but it carries a greater volume of water than any other river. The Amazon is 3,900 miles long and, with its tributary the River Tocantins, it drains an area of nearly 2¾ million square miles—almost half the South American continent. It provides about 30,000 miles of navigable waterways.

The Amazon rises in the Andes Moun-

tains, in Peru. It is formed by the meeting of two other rivers, the Marañón and Ucayali, which rise a mere 100 miles from the Pacific Ocean. As it flows through the forests of northern Brazil, the Amazon is fed by more than 500 other rivers. It eventually empties into the Atlantic, on the Equator, on the northern side of the island of Marajó. Its mouth is 200 miles wide, and the water there is more than 200 feet deep. The volume of water is so great that fresh water is found on the surface 40 miles out to sea.

Ocean-going ships can sail up the river for 1,000 miles, as far as the town of Manaus, and smaller ships can proceed for a further 1,000 miles to Iquitos in Peru. But beyond there navigation becomes difficult because of rapids. The average speed of the Amazon is 1½ miles an hour, but during the rainy season the river overflows its banks and floods thousands of square miles of land.

Some historians believe that the Spanish explorer, Francisco de Orellana,



Location map of the Amazon, showing the vast area of South America drained by the main river and its tributaries.

discovered the Amazon in 1541, but others think that another Spaniard, Vicente Pinzón, saw it when he reached Brazil in 1500.

American Indians The name 'Indians' was given to the native peoples of America by the explorer Columbus. When he discovered the New World in 1492, Columbus mistakenly thought that he had reached the shores of India.

The ancestors of American Indians migrated into America from Asia, crossing the ice sheet which covered the channel of the Bering Straits between 50,000 and 25,000 years ago, and they gradually spread over the whole of North and South America. By far the greater number were living in Mexico and Peru when the continents were discovered by European explorers, and they numbered some 13 millions in all.

Today, the only untouched groups are in the remote Amazonian forests. Their patterns of life and languages varied enormously, and over one thousand different tongues and dialects still survive, though they are slowly dying out.

The most famous Indians are those of North America. These were the natives of the great American Plains, wanderers and hunters of the bison, or buffalo. They were divided into tribes and often

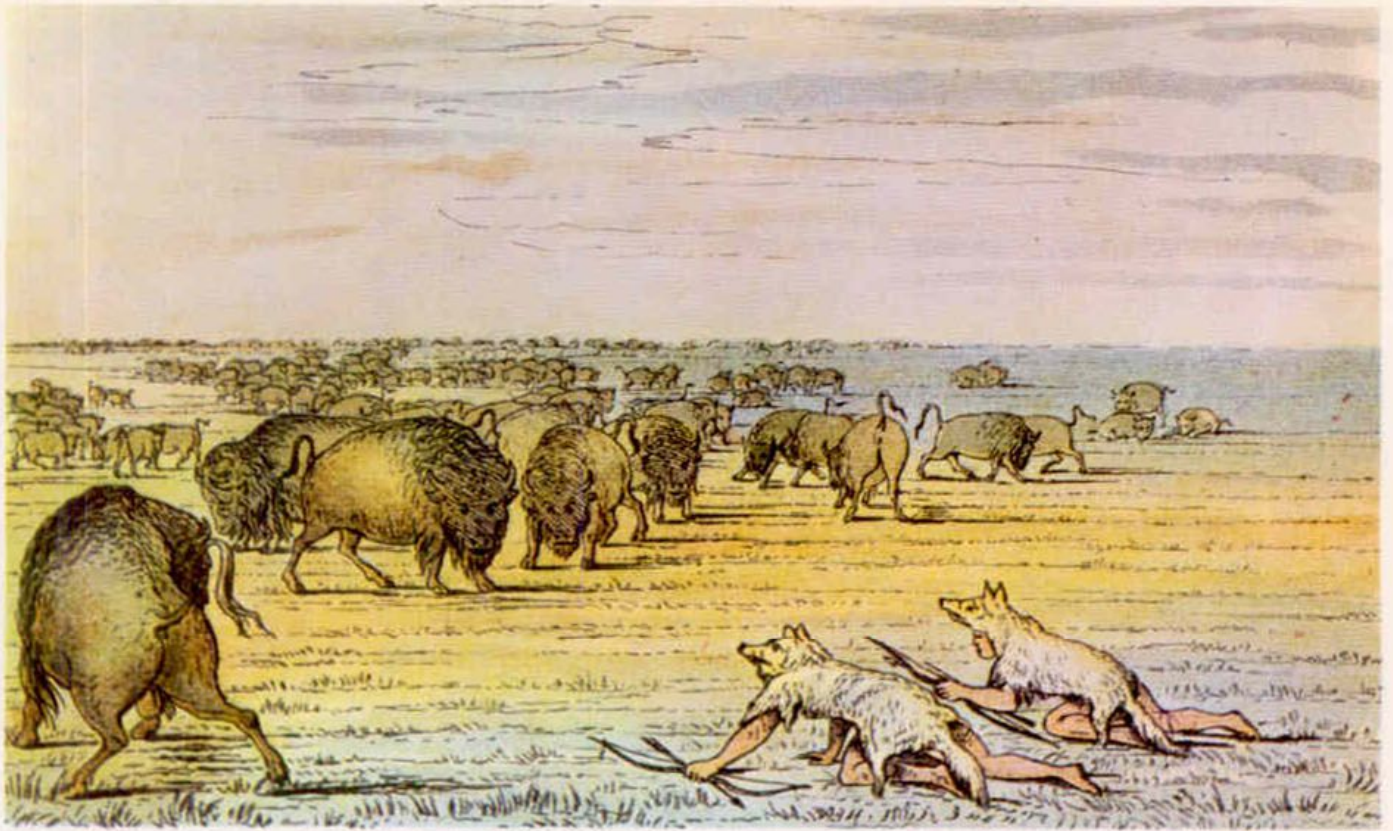


Left: A Brazilian Indian chief.

Right: Some Indians living in the depths of the Amazonian rain-forests have been untouched by modern civilization. They still lead a Stone Age way of life.

Below: North American Indian children. Many leave the reservations when they grow up.





Above: Hunting buffalo. As the buffalo had no fear of wolves, Indians would cover themselves with wolf skins and creep up on the herd. In this way they could get close enough to kill them. Buffalo provided the Indians with food and skins for tents and clothing. Below: A late 16th-century picture of an Indian brave in hunting or ceremonial attire. Right: Ha-na-tah-nu-mah, the Wolf Chief, of the Mandan tribe.



warred with each other. They lived in tents made of buffalo skins, known as wig-wams. They wore *moccasins* (shoes of soft leather) and decorated their clothes with beads. They often wore elaborate head-dresses made of feathers. Even when they wore head-bands decorated with only one or two feathers, these were signs of rank or prowess. Their religion, though simple, was a high code of honour and respect for bravery and ability.

Today they live mainly on *reservations* (large areas of land which are reserved exclusively for their use). They have their own tribal chiefs and councils and run their own affairs to a large extent. Many of the younger Indians have been educated. They attend universities, later entering trades and professions, to become part of the wide North American society which recognises many different races and cultures.

Ammonia is a very valuable gas which is vital to the manufacture of artificial fertilizers. Ammonia, an alkali, combines with sulphuric and nitric acids to form ammonium sulphate and nitrate. These two salts are good fertilizers because they are rich in the nitrogen which plants need for growth. Nitric acid is itself made from ammonia. Some refrigerators have ammonia as a refrigerant.

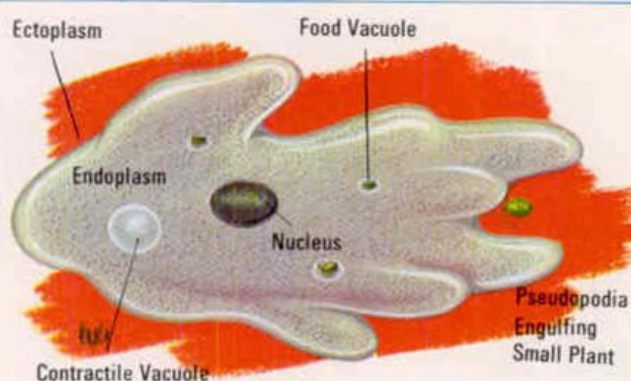
Ammonia is made by a process in which nitrogen extracted from the air combines with hydrogen. It is also a by-product from the manufacture of coal gas. It is lighter than air and has a stinging smell.

Amoeba is a very simple kind of animal. It consists of a single cell, and belongs to the lowest division of the animal kingdom, the *protozoans* (see Protozoans).

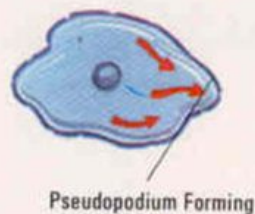
An amoeba moves by extending a *pseudopod*—a finger-like projection of a jelly-like substance called *protoplasm*—in the direction of travel. The rest of the amoeba flows into the pseudopod. To feed, the amoeba extends pseudopods

around a food particle and engulfs it.

An amoeba is about 1/100 of an inch across. It reproduces by dividing into two new amoebae. Amoebae live in fresh and salt water, in soil, and in men and animals. One amoeba causes a type of dysentery in man.



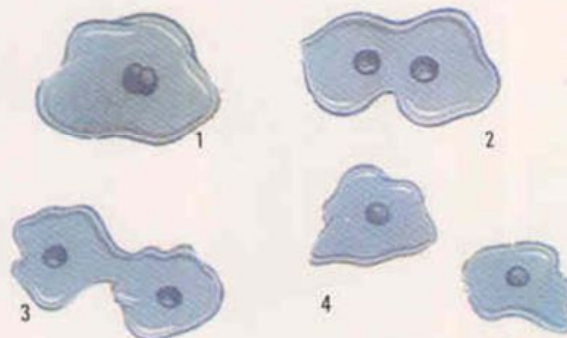
Above: All the processes of life take place within the single cell of the amoeba. A large amoeba is just visible to the naked eye.



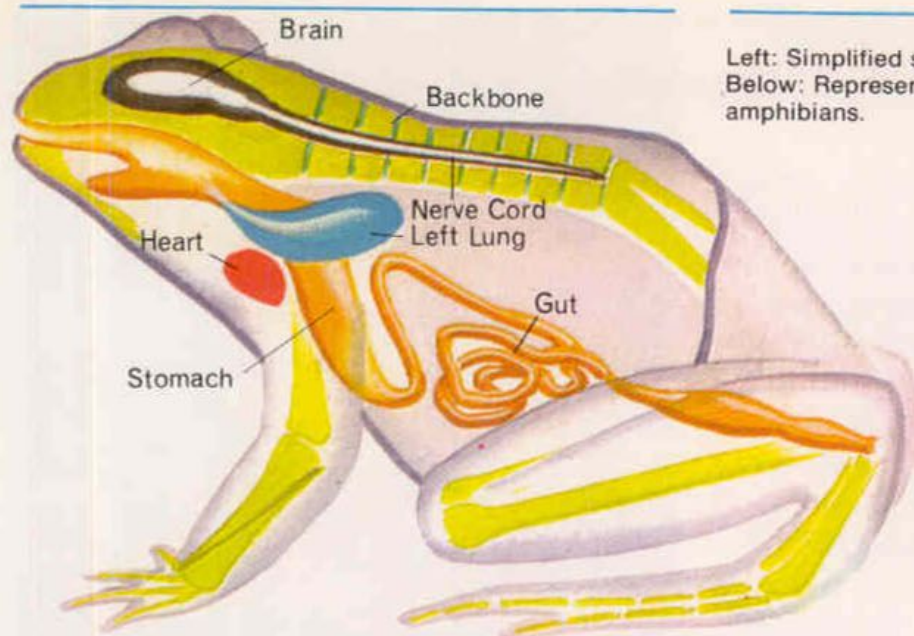
Left: An amoeba moves by the forward flow of its living material.



Below: An amoeba reproduces by dividing in two. First the nucleus divides, then the rest of the cell.



Amphibians are the class of animals that includes frogs, toads, newts, and salamanders. Amphibians first appeared on the Earth about 400 million years ago. They evolved from fishes that came out of the water and developed air-breathing lungs. Many amphibians are equally at home in fresh water and on land, but almost all amphibians breed in water. And if they



Left: Simplified structure of the amphibian body.
Below: Representatives of the three groups of living amphibians.



American Meadow Frog,
or Leopard Frog

Marbled Salamander



South American Caecilian
(Blindworm)



live on land, it is usually near water.

Most amphibians lay eggs that float in water or are attached to stones or water plants. The way in which the *larvae* (the young amphibians) grow into adults is like the evolution process. A frog larva or *tadpole* has gills with which it obtains oxygen from the water to breathe. It swims by using its tail, like a fish. But as the tadpole grows, it loses its fish-like character. Lungs and limbs develop until it is able to leave the water and climb onto the land and breathe air.

Some amphibians, such as newts, spend most of their time in the water. Others, such as frogs and toads, are at home on land and in the water, and some, like the salamanders, live mainly on land.

Amphibians are cold-blooded animals and usually small in size, although the largest, the giant salamander of Japan, is six feet long. There are three main kinds of amphibians: tailed amphibians, tail-less amphibians, and caecilians.

Tailed amphibians include the newts and salamanders. Newts live mostly in water, whereas salamanders are found mainly on land. They have long tails and four short limbs, and are found all over the world except in polar regions.

Tail-less amphibians include frogs and toads. They have large and powerful hind

limbs with which they propel themselves through water and jump about on land. They, too, are found in most regions of the world.

Caecilians are legless amphibians. They live in burrows in moist soil. Some lay eggs, but others produce live young. Caecilians are found in tropical regions around the world.

Amsterdam is the capital, the largest city (pop. 831,000), and a port of the Netherlands (Holland). It lies close to the mouth of the River Amstel. Its large port is connected to sea by the 15-mile-long North Sea Canal. Another canal

links it with the River Waal and the Rhine. With an extensive dock and quay system the port is of prime importance in European trade and communications.

The city is the acknowledged world centre of the diamond cutting and polishing industry and has important banking, insurance and ship-owning interests. It is also a thriving manufacturing city, active with shipbuilding, sugar refining, chemical manufactures and clothing. A feature of the city is its many canals and bridges. There are many fine buildings, among which is the Royal Palace, built in 1665. The Rijksmuseum contains the national collection of paintings. Rembrandt lived in the city and his house is now a museum. The Amsterdam Concertgebouw Orchestra has an international reputation.



Above: Amsterdam is a bustling city famed for its canals, bridges and fine buildings.

Amundsen, Roald (1872-1928), was a Norwegian explorer. He was the first man to reach the South Pole. He also discovered the North-West Passage, a route round the north of Canada between the Atlantic and Pacific oceans that had been sought for hundreds of years.

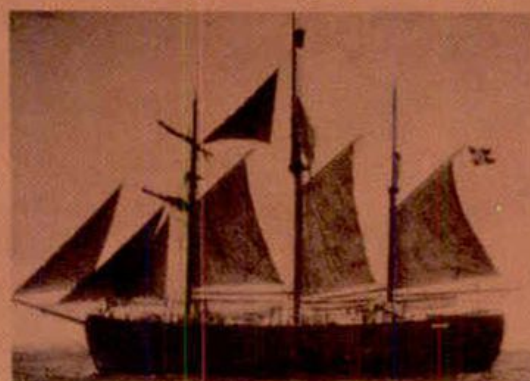
Amundsen was an expert navigator and surveyor. In 1910, he set sail from Norway in the *Fram*, intending to drift with the ice floes towards the North Pole. He aimed to be the first man to reach it. But, just as he was about to start, he learned that the American Admiral Robert Peary had beaten him to it. So Amundsen turned his attention to the Antarctic and the South Pole.

In January 1911, he pitched camp on the ice at the Bay of Whales. In October, Amundsen and his party pushed inland with sleds and dogs. On the 14th December, 1911, they reached the South Pole, beating a British team under Captain Scott by four weeks.

In 1926, Amundsen flew across the North Pole in an airship piloted by Captain Umberto Nobile. Two years later, Nobile was lost on an Arctic expedition. Amundsen set out to look for him by air, and his plane disappeared without trace.



Left: Roald Amundsen.
Below: The *Fram*, the ship that carried Amundsen on his historic journey to Antarctica.



Anaesthetics are substances used to prevent people from feeling pain when an operation is performed. Depending upon the type of operation, it may be necessary to put the patient into a deep sleep, or merely to deaden the pain on one small area of the body. An anaesthetic which causes unconsciousness is called a *general* anaesthetic, and one that affects only a specific area or locality is called a *local* anaesthetic.

Local anaesthetics are used a great deal in dentistry. If a badly decayed tooth is to be drilled, the dentist first injects the surrounding gum with a substance such as *Novocaine*. Within seconds, the area injected begins to grow numb.

In the cases where a general anaesthetic is used, the patient is usually put to sleep quickly by an injection into his veins of the drug *thiopentone*. During the operation, a gas, normally *halothane*, is inhaled by the patient. This ensures continued sleep.

Andersen, Hans Christian (1805-1875), was a Danish writer of fairy tales, a poet, novelist, and playwright. He first wanted to become an opera singer. But after the success of his novel *Improvisatoren*, in 1835, he decided to be a writer. His first collection of fairy tales appeared in 1835, and others were published at intervals until 1872. Although not an immediate success, the stories eventually gained world-wide fame. They were mainly based on folk tales that Andersen cleverly re-wrote. Among the best-loved are *The Red Shoes*, *The Brave Tin Soldier*, and *The Ugly Duckling*.

Andes is the name of the great mountain system that runs down the western coast of South America. It stretches for more than 4,500 miles from Panama in the north to Cape Horn in the south, and is the world's longest mountain chain. Several peaks soar to more than 20,000 feet, and only the Himalayas in Asia are higher than the Andes.



Left: The Andes run for 4,500 miles down the western edge of South America.

Below: The famous statue 'Christ of the Andes' stands high in the mountains on the Chile-Argentinian border. It was erected by the two countries to mark the peaceful settlement of a long-standing dispute and their intention never to wage war against each other.



Parts of the Andes run through Panama, Colombia, Venezuela, Ecuador, Peru, Bolivia, Chile and Argentina. For about half their length, the mountains are more than 12,000 feet high. From the point of view of the Earth's history, they are quite new mountains, but they have been severely affected by weathering. Fast-flowing rivers and enormous glaciers have produced many gorges and valleys. Most of the peaks are volcanic, and some are still active volcanoes.

The northern Andes split into three roughly parallel ranges. The central Andes extend up to 500 miles in width. They form plains that are 12,000 feet high, and some of the highest peaks are found there. Among these are Chimborazo (20,577 ft), Cotopaxi (19,344 ft) and Ojos del Salado (22,590 ft). The southern Andes become lower as they approach Cape Horn, but they also contain Mt. Aconcagua (22,834), the highest mountain in the Americas.



The Andes are rich in minerals—copper, silver, and gold being the most important.

Andorra is a tiny country in the eastern Pyrenees mountains, on the border between France and Spain. It consists of narrow valleys flanked by high peaks. It has no seacoast and no airport, so its roads are all-important. Andorra is a principality ruled jointly by the bishop of Urgel, in Spain, and the president of France.



Location map of Andorra.

Facts and Figures

Area: 191 square miles.
Population: 19,000
Capital: Andorra la Vella.

The ruins of the Khmers' great temple, Angkor Wat, were discovered in 1861 by French explorers in Cambodia. It was built in the 12th century A.D.

The official language is Catalan, but French and Spanish are also spoken, and French and Spanish money is used. Almost all Andorrans are Roman Catholics. Timber, cereals, potatoes, tobacco, and some minerals are exported, but the main industry is tourism. More than a million tourists a year visit Andorra to enjoy its beautiful scenery, winter skiing, and tax-free shopping. According to legend, Andorra was founded by Charlemagne. French-Spanish rule began in the 1200's.

Angkor Wat The Angkor Wat is a superb temple of vast size and great architectural grandeur situated five miles to the south of the ancient walled city of Angkor Thom in what is now known as Cambodia. It is a masterpiece of the classical architecture of the Khmer

Empire which flourished between A.D. 600 and 1434 in the region of Cambodia, Laos and Thailand. The temple was built around A.D. 1140 by King Suryavarman to celebrate many years of victorious fighting. It is adorned in low relief with many scenes from the epics of the Hindu religion. For many years the city and the temple were lost in the forests but they were re-discovered by French explorers in 1861.

Anglesey or Môn (in Welsh), most northerly of the Welsh counties, is an island. Its area is 275 square miles. It lies off the coast of Caernarvonshire, from which it is separated by the Menai Strait. The Strait is crossed by two bridges. Anglesey's county town is Beaumaris, on the Menai Strait.

Anglesey is flat and low-lying, with few areas that rise above 250 feet. Its climate is mild. Sheep and cattle graze on its rich grasslands, and some crops are grown. The dairy industry is centred on Llan-

The Romans mined copper in Anglesey. In the 18th century mining again became important in the island when it was discovered that Parys mountain was composed almost entirely of copper ore. It became the largest copper mine in Europe until the ore was exhausted in about 1850.

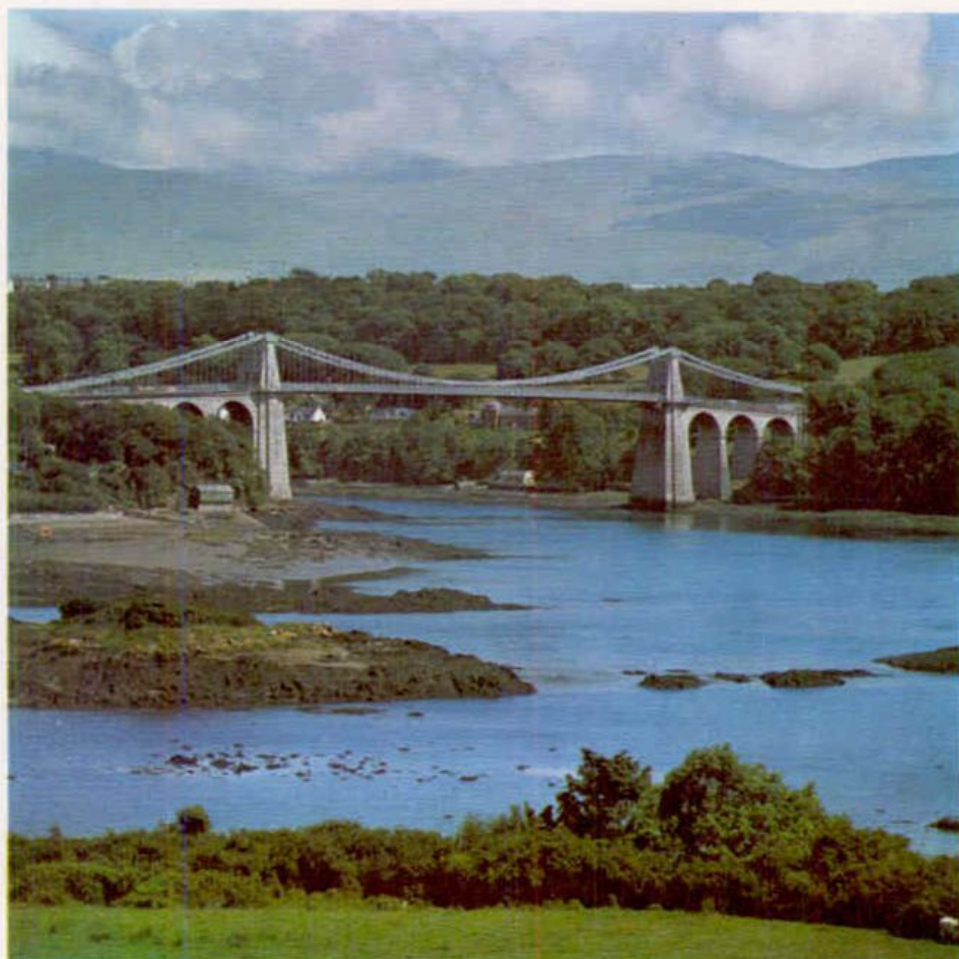
gefni, which is also the chief administrative town. Holyhead, on Holy Island, off the west coast, is the terminus of a ferry service to Ireland. A nuclear power station is located at Wylfa.

Angling is fishing with rod and line, as distinct from net fishing.

The simplest method of angling, still widely practised, is to tie a baited hook and line to the end of a long pole. Lead shot is used to add weight, plus a float that dips when a fish has taken the bait.

Anglers use many different types of **tackle**, or equipment. Rods are usually made of metal or of fibreglass. The line, which is rated according to pounds of pressure required to break it, is wound on

The Menai Bridge, which joins Anglesey to the mainland of Wales, was built by the Scottish engineer Thomas Telford in 1826. It was then the largest suspension bridge in the world.



one of three types of reel: bait-casting, spinning, or fly-casting.

The usual method of angling for trout and salmon, most prized of the freshwater fish, is with artificial flies. Fly-casting is a highly specialised skill. A lighter, shorter and springier rod, often of split cane with a steel centre, is used.

Equipment for sea fishing must be stronger, and weighted more heavily because of the tide. Hooks are bigger, and sea creatures such as lugworms and shrimps are used for bait. The marine equivalent of salmon fishing is fishing for bass, the best fighter.

The Egyptians used line and bait to catch fish long before the Christian era, while the invention of the reel dates back to the 15th century. In 1653 Izaak Walton, 'patron saint of anglers', published his world-renowned book, *The Compleat Angler*.

Anglo Saxons In the fifth century A.D., Britain was attacked by fierce warriors



A Saxon cross, carved with a spiral decoration, at Eyam in Derbyshire.



from southern Denmark and northern Germany. They were called Angles and Saxons (after the Saex, or short sword, with which they fought). Britain was no longer defended by Roman soldiers and the Saxons found plenty of plunder. They conquered most of Britain except for the North and the West. The land they settled in came to be called England (Angle-land).

The Saxons lived in tribes, each with its chief and warriors (thegns). Their laws were primitive, and each family avenged any wrong done to one of its members. They worshipped pagan gods such as Thor, the God of Thunder. The Saxons were skilled metalworkers, and beautiful examples of their craft were found at Sutton Hoo (Suffolk) in 1939. They lived in wooden buildings in small villages and avoided the stone villas and towns left by the Romans. The main building in each village was the chief's hall, which was often used for great feasts.

At first England was divided into Seven

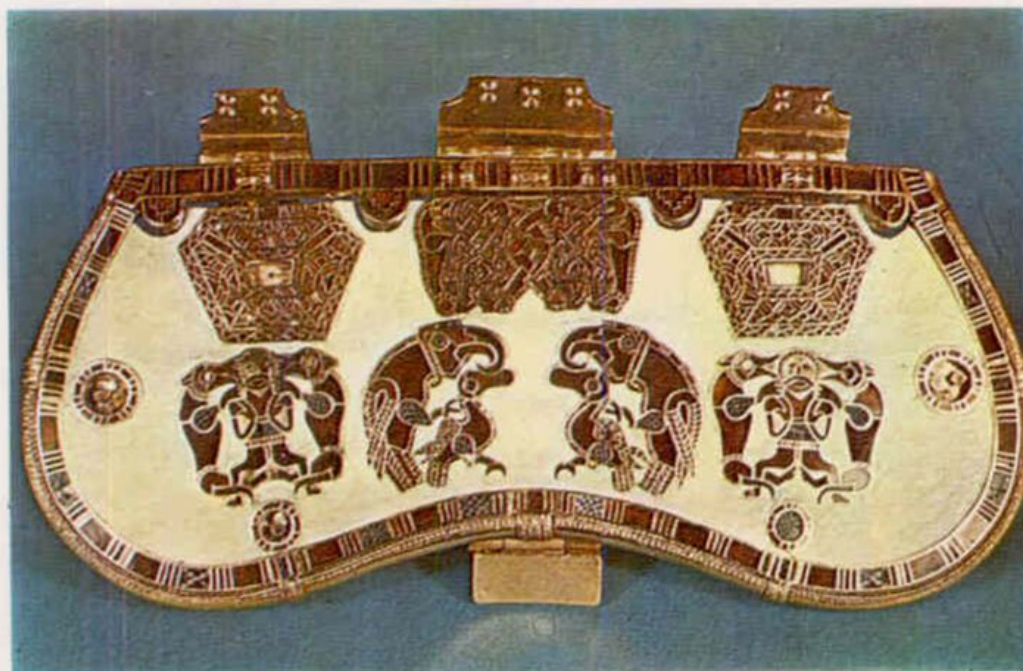
Kingdoms (the Heptarchy), but during the ninth century invasions (see Vikings) King Alfred united the Saxons. After this, the Kings of Wessex ruled over all England. In the seventh century, the Saxons had become Christians. Monasteries and churches were built. Saxon monks became skilled in the art of illuminating books. Learning spread, so that laws were written down. So were ancient poems, such as *Beowulf*, which had previously been sung by minstrels.

After 1066, England was not ruled by Saxon kings, but the language and customs of the Saxons continued to live on to shape the English way of life.

Luanda, but it is planned to move the capital to Nova Lisboa.

The country's natural resources include diamonds and petroleum. However, most of the people are farmers. The chief crops include coffee, cotton, sugar and tobacco.

Angola is officially a Portuguese province, but most of its people are black Africans. Part of Angola was claimed for Portugal in 1574. In 1641, the Dutch took over the region but the Portuguese regained control in 1648. During the 1960's there were uprisings against the Portuguese government. Fighting occurred between African nationalists and Portuguese soldiers.



Left: A purse-lid from the Sutton Hoo treasure. The excavation of a burial ship at Sutton Hoo, Suffolk, in 1939, revealed the treasures of a Saxon king, including silver bowls and garnet-set gold jewellery. Forty gold coins date the burial to a period between A.D. 650 and 655.

Angola This large Portuguese territory faces the Atlantic Ocean in southwestern Africa. It covers an area of 481,352 square miles and has a population of 5,362,000. Its administrative centre and capital is



The location map above the position of Angola, a Portuguese territory in southern Africa.

Angus, a county in eastern Scotland, is known to farmers all over the world because of its breed of beef cattle, the black Aberdeen-Angus. It is a popular tourist area, much visited by climbers, anglers, and skiers. Its county town is Forfar, but its largest city is Dundee. The area of Angus is 855 square miles. The county was formerly named Forfarshire.

Angus is one of the most beautiful counties of Britain, with extremely varied scenery. The rugged Grampian mountains in the north are separated from the Sidlaw hills in the south by the fertile Strathmore plain. In the east is a coastal

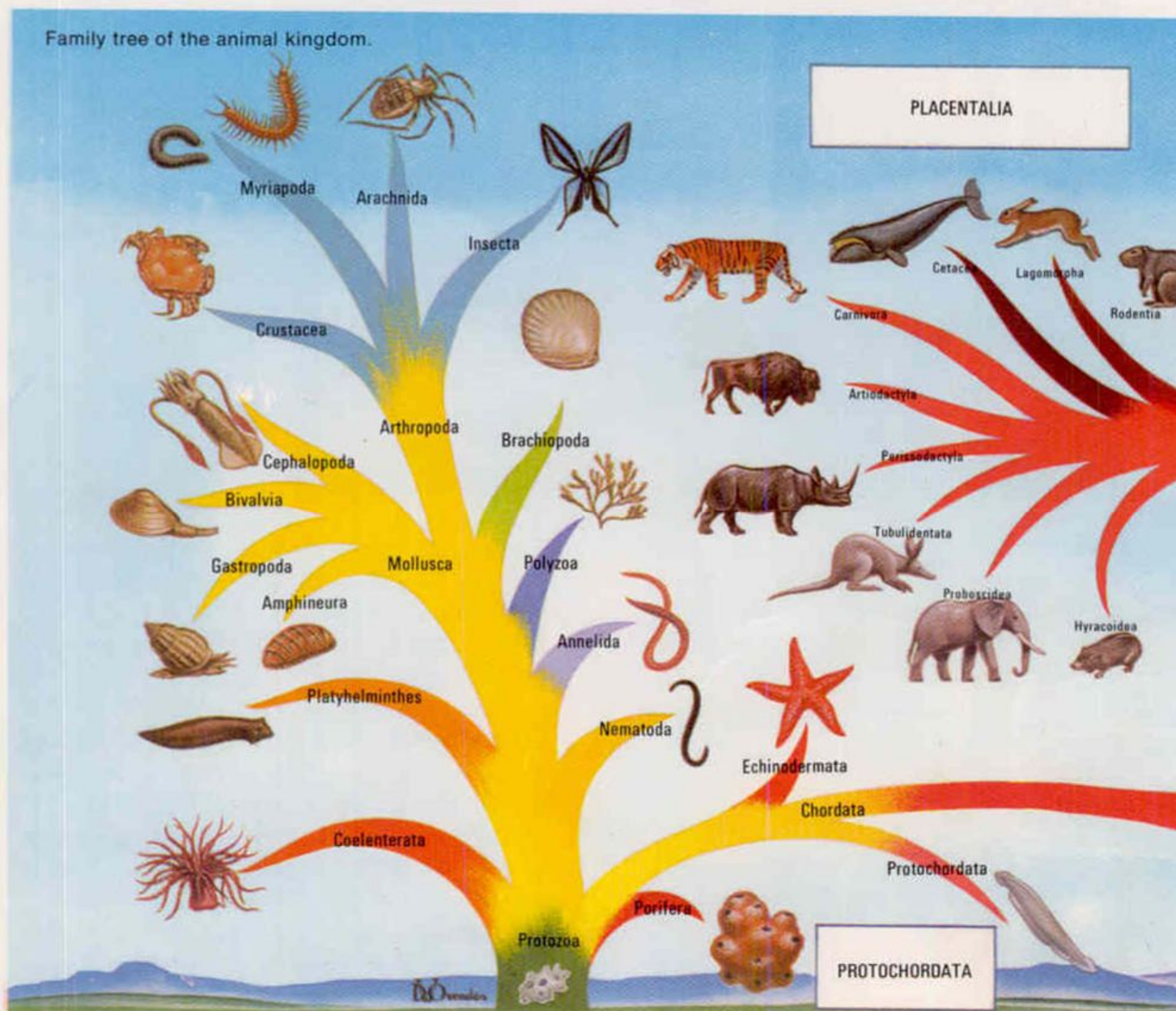
plain bounded by the North Sea, and in the south is the Firth of Tay. The Grampians are pierced by romantic *glens* (valleys), formed chiefly by the rivers North Esk and South Esk and their tributaries.

Dundee, with its jute and linen factories, is the chief centre of the textile industry. It is also an important educational centre. At Arbroath, in 1320, the Scottish nobles declared their support for Robert Bruce against the English. Offshore from Arbroath is the Inchcape Rock, made famous by Southey's poem.

Animal Kingdom This is one of the two great sections into which biologists divide most living things. The other

section is the plant kingdom (see Plants). In many cases, the differences between animals and plants are obvious. Plants are fixed in one place; they grow by spreading out; and are mainly green in colour. Animals are more compact and move under their own power. But some microscopic plants can travel about in water by moving tiny hairs (see Algae). Again, animals eat plants or other animals, whereas plants make their own food. Yet there are plants that catch and feed on insects (see Insect-eating plants).

There is a much greater variety of animals than there is of plants. Biologists know of nearly a million different species (kinds) of animals, but only about a third as many plants. Animals vary from the



Protochordata: Chordates that have no true brain and no braincase or backbone. They lack a heart and the type of kidney typical of vertebrates. Examples are the sea-squirts, lancelets and acorn worms.

Cyclostomata: Vertebrate chordates with an endoskeleton of cartilage. They have no jaws and lack scales and bones. Examples are the lampreys, hag fishes and slime hags.

Elasmobranchii: Fishes with well-developed jaws. They have an endoskeleton made of cartilage; bone is entirely lacking. The skin is covered with horny, tooth-like scales.

Choanichthyes: Fishes with internal nostrils. Their paired fins have fleshy lobes. Examples are the coelacanth and lung fishes.

Actinopterygii: Ray-finned fishes with well-developed jaws. They have an endoskeleton made almost entirely of bone.

Amphibia: Cold-blooded vertebrate animals that usually need to return to the water to breed. Except in some limbless forms, they lack scales. They usually have lungs and a moist skin through which they can breathe. Examples are frogs, toads, newts and salamanders.

Reptilia: Cold-blooded vertebrates fitted for life on land. The skin is dry and covered in scales. They have lungs and show an advance on amphibians in laying shelled

eggs which hatch on land. Examples are crocodiles, snakes, turtles and lizards.

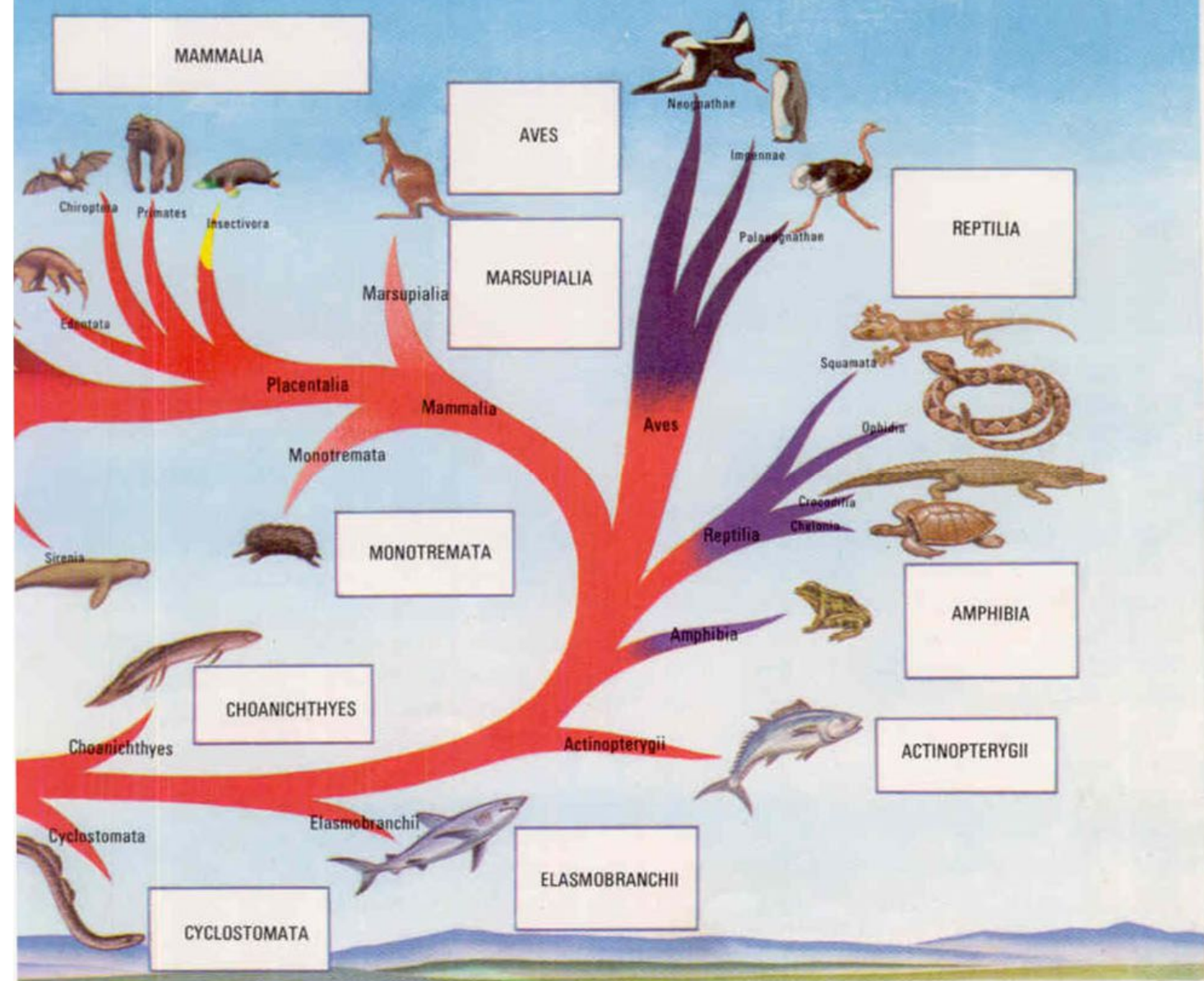
Aves: Warm-blooded vertebrates that have feathers. Like most reptiles they lay shelled eggs. Another reptilian characteristic is the presence of scales on the legs and feet. The fore-limbs are modified as wings.

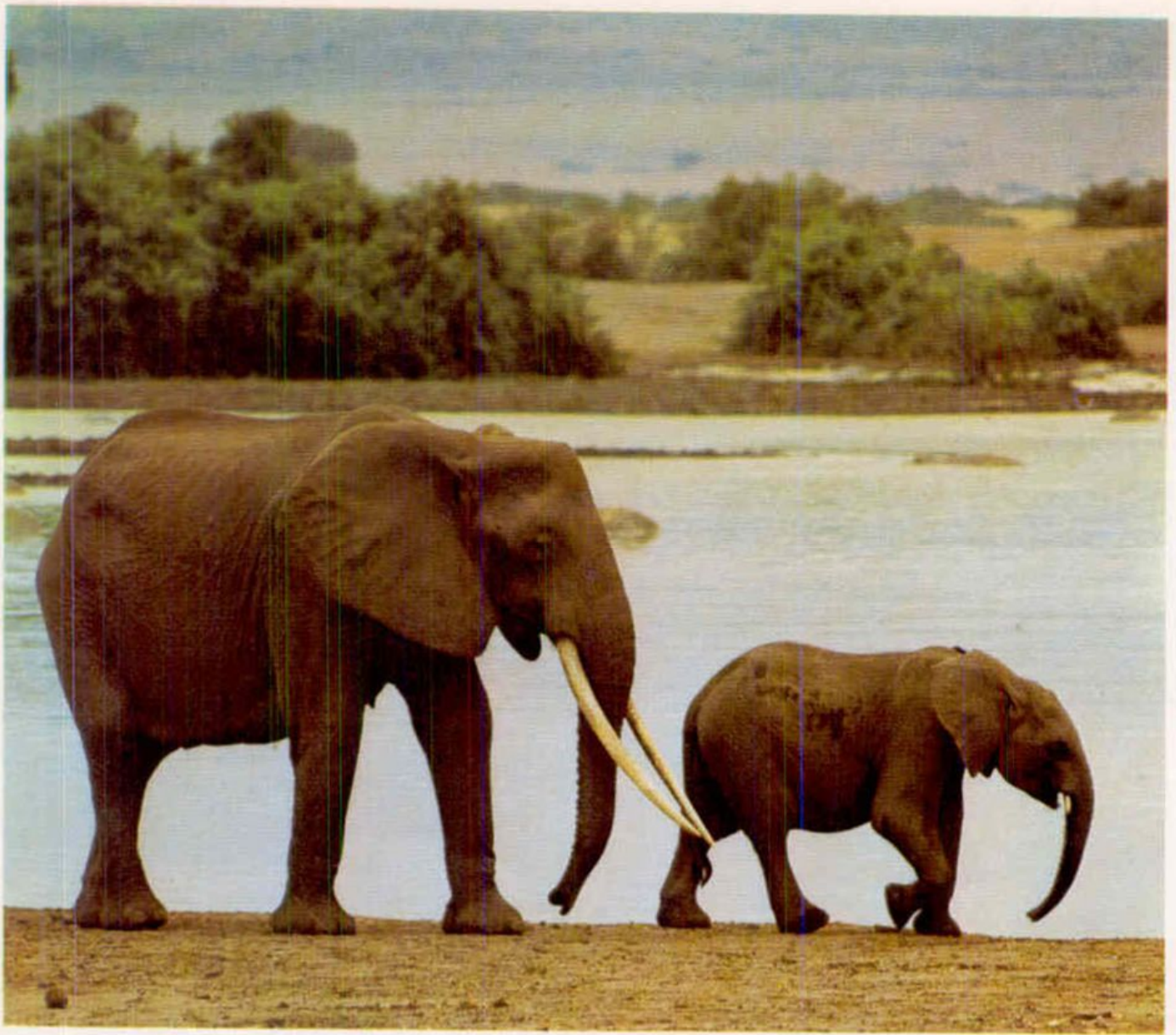
Mammalia: Warm-blooded vertebrates that have hair. The young are nourished with milk which is provided by milk or mammary glands. Except for the monotremes which lay eggs, mammals bear their young alive.

Monotremata: The egg-laying mammals. Examples are the platypus and spiny ant-eater. Neither animal has teeth.

Marsupialia: The pouched mammals. These bear their young alive but in a small, relatively unformed state. The female has a pouch on the lower part of the abdomen in which the young are carried and suckled until they are able to fend for themselves. Examples are the kangaroos, wallabies, koalas and opossums.

Placentalia: Mammals in which the young during their early development are connected to the mother by a 'plate' of tissue—the placenta. This passes on food, oxygen and chemicals to the embryo. The young are born at a more advanced stage than in other mammals. Examples are the rodents, cats, dogs, horses, sheep, monkeys, apes and man.





tiny one-celled amoeba—which can be seen clearly only under a microscope—to the huge blue whale, which may reach a length of 100 feet and a weight of 150 tons. Animals live in almost every part of the world: from the great depths of the oceans—where there are strange-shaped fish with glowing bodies—to high mountain regions. Animals even live in the bitter cold of the polar wastes and in the searing heat of the deserts.

One important difference between plants and animals is that most animals have far more accurate and sensitive senses (see Senses). They can learn more precisely what is happening in their surroundings, and react quickly to it. This is because they have some kind of nervous system. As a result, they can avoid danger

The largest living land mammals are the elephants. They are quite closely related to the tiny hyrax!

and search for food and shelter. When the weather changes or a natural disaster such as fire or flood occurs they may be able to move to somewhere where the conditions are better. As a result, they have a better chance of survival. Animals can also *adapt* (change) to varying conditions more quickly. It is this great ability to adapt that has led to the great variety of animals. This has occurred through the process of evolution (see Evolution).

But, in spite of this variety, most animals have similar features to some other animals. Biologists use such similarities as the basis on which to classify animals into groups. The closer they are related

—the more similar they are—the closer is the grouping. In this way, a number of species may be grouped into a single *genus*, several of which make up a *family*. Families are themselves grouped into *orders*. A number of orders make a *class*, and several classes comprise a *phylum*. The 20-odd phyla are the principal groups that make up the animal kingdom.

By far the biggest of these in terms of the number of species is the phylum *Arthropoda*, the arthropods. This includes all the insects, crustaceans, spiders, scorpions, centipedes and millipedes. These groups are themselves classes within the phylum. Insects alone number over 800,000 species—more than three-quarters of all the known species of animals.

Another important phylum is *Mollusca*, the molluscs. Most of these creatures have shells—examples include snails, clams, limpets, oysters and mussels. But some molluscs, such as the squid and octopus,

have entirely soft bodies, with no shells.

Perhaps the most varied and most important phylum is the *Chordata*, the chordates. What distinguishes them from all other animals is the hollow nerve cord that extends the length of their backs. They also have some kind of supporting rod of elastic material. In the more primitive chordates, this is a simple *notochord*, but the *vertebrates*—the most important group of chordates—all have backbones.

The vertebrates are the most advanced and most successful of all the animals. They include the fishes, amphibians, reptiles, birds and mammals. The mammals are the most advanced of the vertebrates, and the most advanced mammal is man himself: he is the most successful animal that has ever lived.

Animal products Man makes use of many materials derived from the bodies of animals. Primitive hunters and modern

Some of the many everyday things made from animals. Their skins are used for leather, from soft suede for gloves to tough hide for cases. The feathers of geese and ducks are used for filling quilts, and brushes are made from pigs' bristles. Sheep provide us with wool, and musk and ambergris are used in making scent. Primitive peoples shape animal bones into harpoon and arrow heads and make bone needles. The bones and hooves of animals can also be used to make glue. Sadly, men have hunted some animals so relentlessly for their valuable products that they are in great danger of extinction.





Queen Anne was the younger daughter of the Stuart King James II of England. None of her 17 children survived her.

meat processors know that with a little ingenuity a good use can be found for almost any part of an animal after the flesh is eaten.

Eskimos make needles, harpoon tips, and other tools from whale bones and walrus tusks. They fashion warm clothing and bedding out of sealskin furs, and burn whale oil for fuel. Indians use stretched deerskins for tents and canoes. They decorate their bodies with feathers and shells.

Modern manufacturers make leather goods of all kinds including shoes, boots, belts, briefcases, and book covers from the skins of various animals. Bones, hooves, and hides are used in making glue, and ox blood goes into shoe polish. Horsehair for mattresses, goose and duck

down for quilts and beeswax for candles are other valuable animal products.

Ankara is the capital of Turkey. It is set on a hill in the plain of Anatolia, in eastern (Asiatic) Turkey. The city with its suburbs has a population of 1,302,512. Ankara is a beautiful modern city, contrasting pleasantly with the dry countryside surrounding it. Formerly a small provincial town called Angora, it was declared the capital of the new Turkish Republic by Kemal Atatürk in 1923.

Anne (1665-1714), queen of Great Britain and Ireland, succeeded her brother-in-law King William III on the throne in 1702. She was the younger daughter of King James II, and was the last Stuart monarch. Anne was queen when England and Scotland were united in 1707.

During her reign, the Duke of Marlborough won many victories over the French in the War of the Spanish Succession. He and his wife had much influence over the queen, but later she favoured his political opponents the Tories.

Anne married Prince George of Denmark in 1683. He died in 1708. None of her 17 children survived her, and when she died the Elector of Hanover became king as George I.

Annual plants are those that grow from seed, mature, flower, set their own seeds, and then die all within the space of one growing season. They are distinguished from *biennials*, which take two years to achieve a similar cycle, and from *perennials* which die back and grow again for a number of years. Familiar garden annuals include stocks, nasturtiums, petunias, godetias and asters.

Antarctica is the fifth largest continent in the world. It is a roughly circular land mass lying around the South Pole and surrounded by the Antarctic Ocean. With its area of about 5,100,000 square miles,



Above: Surveying in Antarctica. As yet large areas of this isolated continent remain unmapped.

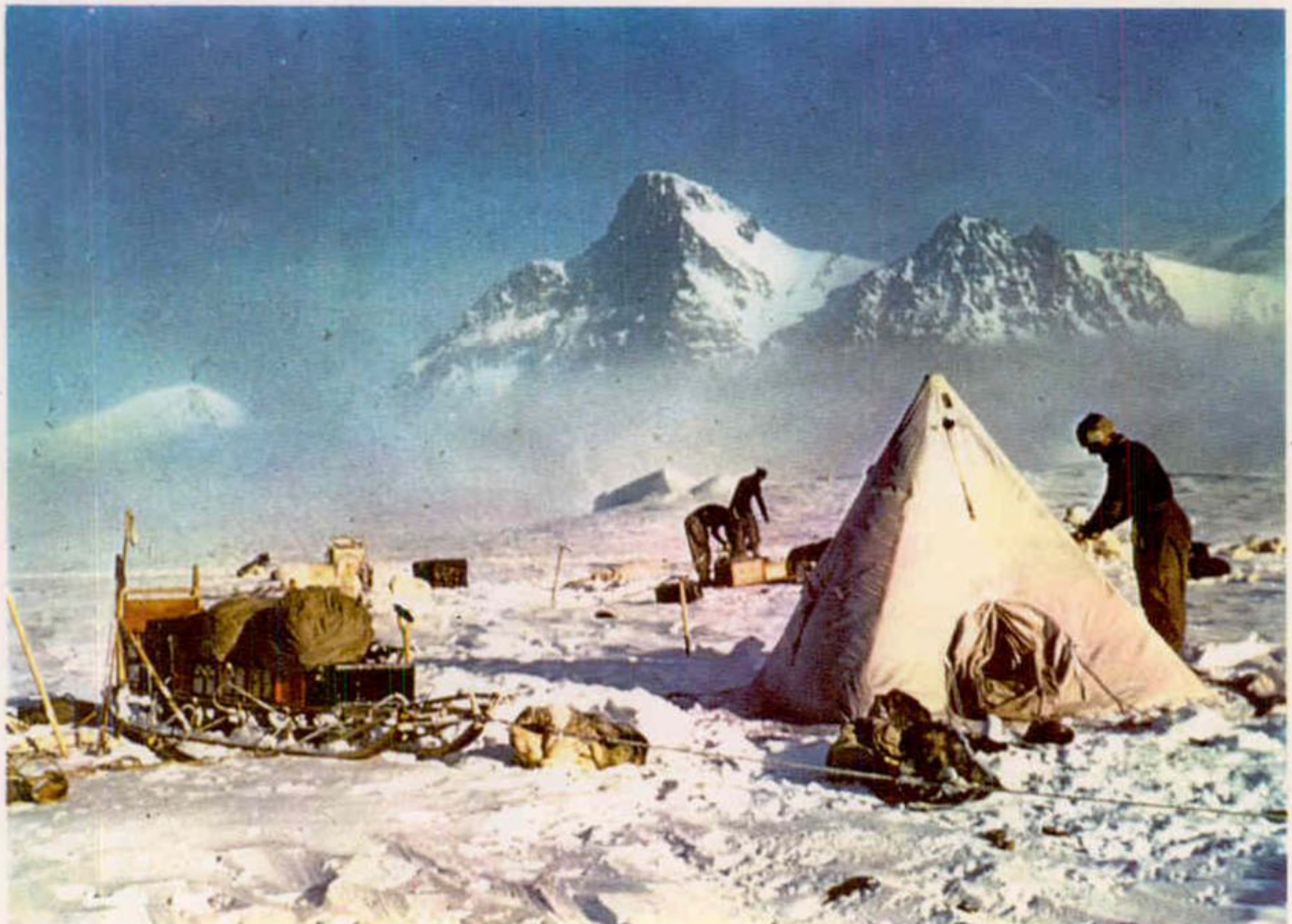


Above right: Hidden crevasses are one of the greatest hazards to Antarctic travellers. Long, tracked pontoons help to spread a vehicle's weight over the ice, but accidents can still happen. This tractor was safely retrieved despite its perilous position.

Right: In temperatures around minus 50° F the emperor penguin rears its solitary chick. The egg, and later the chick, is supported on the adult penguin's webbed feet and protected from the cold by its thick feathers.



Below: An early-morning scene in Antarctica as a scientific expedition prepares to break camp. Mist hangs low over the desolate ice-shrouded landscape.



Antarctica is larger than either Australia or Europe.

Until the 1900's, nobody had ever lived in Antarctica, because it was the coldest place on Earth. The only people who live there today are whalers and scientists. This desolate region is almost completely covered by a great ice sheet. The ice is generally more than a mile thick and in places it is two-and-a-half miles thick. Most of the world's permanent ice is in this region. Blinding snow storms and fierce, icy winds make Antarctica a most unattractive place for all forms of life.

In a few places, mountain peaks called *nunataks* appear above the level of the ice. These peaks are part of great mountain chains that lie buried beneath the ice. Antarctica is very mountainous and some peaks rise to 16,000 feet.

The climate of Antarctica is extremely severe. The world's lowest temperature, -126.9°F (-88.3°C), was recorded there in 1960. In winter, temperatures often fall below -70°F (-57°C).

The only plant life found in Antarctica consists of some algae, lichens and mosses. But large numbers of penguins, petrels and seals live in some coastal

The Antarctic icecap has been estimated to contain 90% of the world's ice. If this were to melt, sea levels would rise by about 130 feet, and vast areas of land would be flooded.

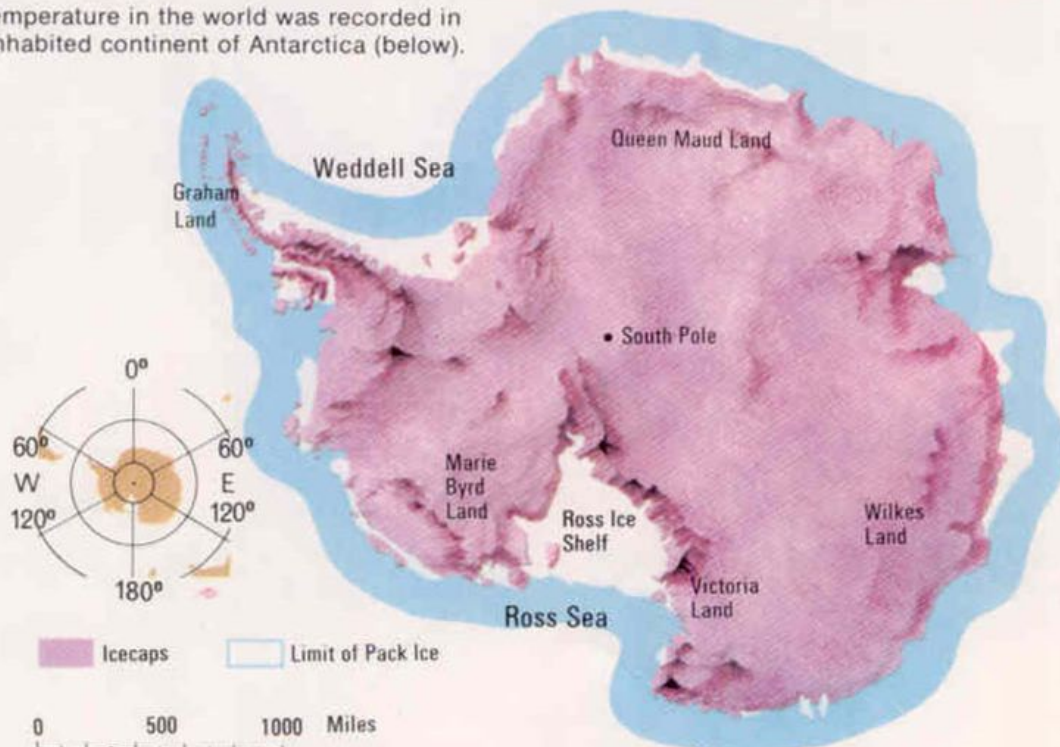
areas. The ocean waters are rich in plant and fish life and whales are hunted in the seas that encircle the continent.

Antarctica was the last continent to be discovered and explored. The British seaman, Captain James Cook, sailed around the continent between 1772 and 1775. He did not reach the mainland, but saw much of the rich life in the seas. Hearing his reports, many sailors began to hunt seals and whales in the region.

In 1820 the coast of Antarctica was sighted. The first landing was probably made by an American sailor, John Davis, in 1821. The British explorer Robert Falcon Scott made the first major inland journey in 1901-4. But the first man to reach the South Pole was the Norwegian Roald Amundsen, who planted his country's flag there on December 14, 1911. A British team led by Scott arrived about a month later. But Scott and his companions died in the cold on their return.

The development of aircraft speeded the exploration of Antarctica. In 1929 the

The coldest temperature in the world was recorded in the huge, uninhabited continent of Antarctica (below).





Left: Impala are always intensely alert and at the slightest sign of danger will flee in a magnificent series of leaps and bounds.

Right: The horns of the sable antelope sweep back from its black-and-white-striped face like a pair of scimitars.



American Richard E. Byrd became the first man to fly over the South Pole. In 1959 an agreement was signed by 12 nations ensuring the use of Antarctica for peaceful purposes only.

Ant-eaters are strange-shaped mammals living in South America. There are three main kinds: the giant ant-eater, which grows up to seven feet long; the lesser ant-eater, or tamandua, which reaches three and a half feet; and the pigmy ant-eater, about the size of a squirrel. All have extremely long snouts, tiny mouths, and long worm-like tongues. They eat mainly termites (white ants). They use the strong claws on their front feet to break open a termite nest, then lick up the insects with their tongues.

The spiny ant-eaters of Australia are primitive egg-laying mammals. They are quite unrelated to the South American ant-eaters. (See Monotremes.)



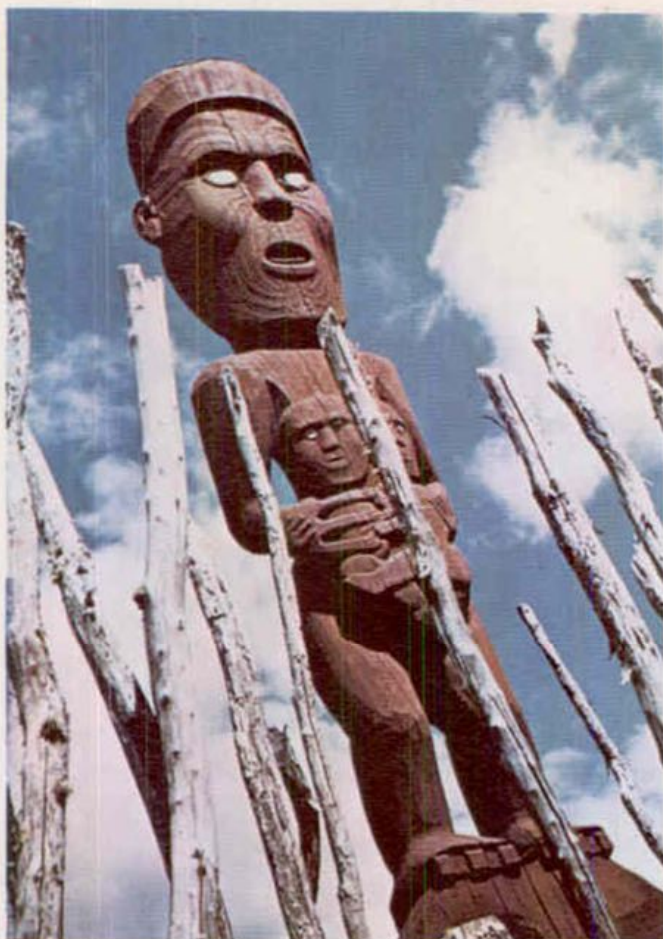
The giant ant-eater stands about two feet high and may measure seven feet from snout to tail.

Antelopes are herbivorous mammals, usually with long horns. They live mainly in Africa, but some species live in southern Asia. They generally live in herds on open grasslands or in areas with a few trees. They are very timid creatures, and run at the first sign of danger. They are extremely graceful when they run, often taking long, smooth leaps.

At first sight, antelopes may look rather like deer, but they are more closely related to goats, sheep and cattle than to deer. Deer, for instance, do not have true horns. Their branched antlers have a velvety covering and are shed each autumn and grow again each spring. Antelopes, on the other hand, have true horns that remain for life. They do not branch, and have a bony core with a covering of horn. (See Horns and antlers.)

There are many different species of antelopes. In some, only the male has horns, but both sexes usually have them. The horns are generally curved, and may curl in a spiral. Some kinds have ridged horns. Most antelopes have smooth, brown or grey hair. Many species have white or black markings, particularly white underparts. They all have hoofs.

The smallest antelope—the royal antelope—stands only 12 inches high at the shoulder. The gnu, on the other hand, reaches over four feet and weighs 500 lb. Some antelopes of South Africa can make huge leaps. The springbok, for example, can jump up 10 feet in the air when it is frightened. It then runs off at up to 60



Above: Anthropologists can learn much from traditional forms of art, such as this carved post from a Maori meeting house. Below: A Zulu chief. Customs of ancient tribes are also studied by anthropologists.



miles an hour. The impala can cover 30 feet in a single leap, reaching a height of six feet.

Anthropology is the science of Man and the kinds of society that he creates. The word comes from the Greek words *anthropos* and *logos*, meaning man and knowledge. Anthropologists *classify* (divide into classes) and analyse different kinds of society in history and in the present. They are concerned with people's beliefs and behaviour in the society they live in, and how their beliefs and behaviour are affected by that society. To describe these patterns of belief and behaviour, anthropologists use the word *culture* and talk about the culture of a society or group of people. Other sciences, such as *sociology*, also deal with man and his behaviour. Anthropology differs from these because it concentrates mainly on the societies of primitive peoples. From these studies, anthropologists hope to learn how more advanced societies work.

Anthropology has two main divisions, *physical anthropology* and *cultural anthropology*. Physical anthropologists study human *evolution* (development) through the ages. This includes human *palaeontology*—that is, the study of human fossil remains, and the study of the racial groupings of man. Cultural anthropologists study everything that makes up culture. They examine the material remains, such as the cooking utensils and weapons, of prehistoric or extinct peoples. They also study and describe living societies and languages. In *applied anthropology*, practical problems are solved. For example, the primitive tribes of Indians in the remote forest areas of Brazil are threatened with destruction of their traditional way of life as civilization advances. Anthropologists try to understand the problems of the Indians and help to bring their way of life into harmony with modern society.

Anthropology began as a separate

science in the late 1700's and early 1800's, as a result of the so-called period of *Enlightenment* of the 1700's, when philosophers and scientists became curious about the origins of Man and society. (See Archaeology.)

Antibiotics are substances, produced by living things, which are poisonous to bacteria and other micro-organisms. A more general meaning for antibiotic is any substance which can restrict the growth of such micro-organisms. In medicine, antibiotics are used to destroy disease-producing bacteria, and also to prevent these bacteria from taking hold in a patient, and causing an infection.

For a long time, it was thought that any medicine that had the power to kill a particular microbe would also kill the patient under treatment. The first person to discover a drug that was both destructive and yet safe to administer was a scientist named Paul Ehrlich when he successfully used the compound salvarsan in 1909.

The next advance in antibiotics was the development of a group of drugs called the *sulphonamides*. These were a variety of compounds *synthesized* (made up) by chemists. The first one was put on the market in Germany, in 1935. It was a red dye, *Prontosil*, which had been proved experimentally to cure infections caused by a virulent streptococcus bacteria. Gerhard Domagk, the discoverer of *Prontosil*, soon learnt, however, that the dye itself was not necessary for treatment. The important ingredient was a simpler substance, one of the sulphonamides, contained in it. Used in the treatment of puerperal fever, a disease of women in childbirth, *Prontosil* reduced the death rate from 71% to zero.

A still more important discovery was to come. This was penicillin, not a synthetic substance, but one naturally produced by living moulds. Alexander Fleming, a British scientist, noticed in 1928 that some moulds that were growing amidst bacteria

cultures were surrounded by a clear area. He confirmed by experiment that the juice from these penicillium moulds destroyed bacteria, but was absolutely harmless to animals. It was many years before penicillin was available for the treatment of diseases. The freshly extracted juice remained effective for only a few days, and experiments, by Fleming and other scientists, continued through World War II, before the drug became widely used.

Penicillin is used in the treatment of pneumonia, and a great many other infections. Streptomycin, a more recent antibiotic, is used against tuberculosis.

Antifreeze is any chemical that is added to a liquid to lower its freezing point. An antifreeze is often added to the cooling liquid (usually water) in the radiator of a motor car or other vehicle that has an internal combustion engine. It prevents the cooling liquid from freezing, and damaging the engine. Antifreezes are also used in refrigerators and to prevent icing on the wings of aircraft. Common antifreezes include ethyl alcohol and ethylene glycol.

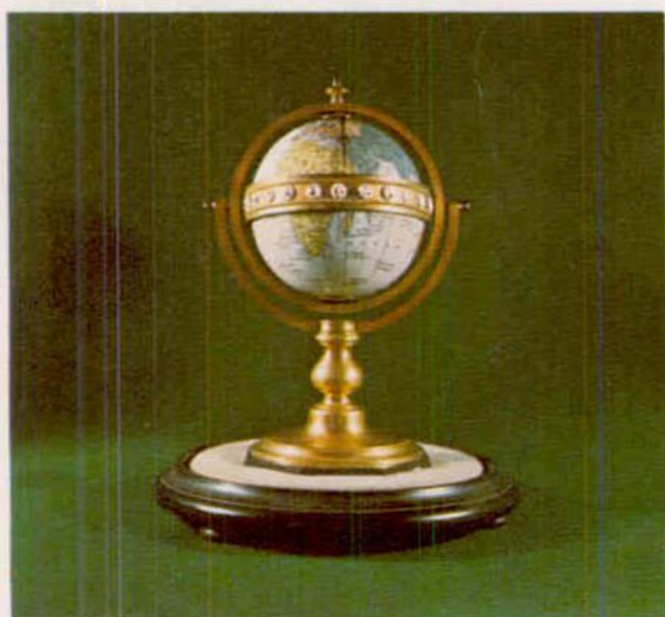
Antiques are old objects that are valued by collectors for their age, rarity, beauty, or fine craftsmanship. They can also be useful and decorative, in spite of their age. Antique dealers are generally agreed that an item must be at least 100 years old in order to be regarded as an antique.

There are many different kinds of antiques. Paintings, sculpture, pottery and porcelain, glassware, ivory, jewellery, metalware, furniture, clocks and watches, and books and manuscripts are some of the items usually found in antique shops. But some collectors specialize in less common treasures. There may be fewer people who would care to fill their homes with arms and armour, or antique fans, or snuff boxes, for example, but such objects are just as keenly sought as the more general items.

Prices for antiques vary according to



Antique furniture and ornaments are much prized. Above: A walnut veneered cabinet, made in the late 1600's. Right: An English mirror made around 1743. Below: This French globe clock of 1873 just qualifies as an antique since it is over a hundred years old.



their condition. The more nearly perfect an object is, the greater its value. Even a tiny imperfection in some objects can make them almost worthless. This is particularly true of pottery and porcelain, which should be quite free of chips or cracks to be of any value.

Generally speaking, an antique in good condition will increase in value with age. There are exceptions to this, and items that can be identified as having been made by a famous craftsman or

Antiques are so valuable that many forgeries and fakes are on the market. Some are so skilfully made that even experts are deceived by them.

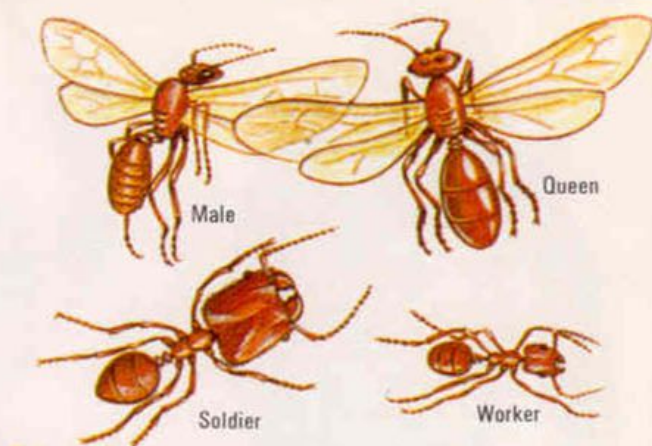
workshop will always fetch high prices, regardless of age.

Many treasures of the past are bought and sold in famous auction rooms, located in the world's great cities. Most of the items go into private collections. But some are bought for national museums and art galleries.

Antiseptic is a chemical that kills germs or prevents them multiplying. Antiseptics are commonly used to disinfect cuts or other wounds. They are also used in mouth washes and gargles to kill germs in the mouth and throat. They are added to washing-up liquids to kill germs on cutlery, crockery, and other objects that come in contact with food. In hospitals they are used to disinfect surgical instruments and appliances.

Antiseptics were first used in the 1860's by the British surgeon Joseph Lister (later Lord Lister). Lister studied the work of the French chemist Louis Pasteur and decided that *micro-organisms* (germs) were the cause of wounds refusing to heal. He used carbolic acid as an antiseptic in his operations, and as a result deaths from infection after operations fell from 50 per cent to less than 3 per cent.

Ants are found all over the world, except in polar regions, and there are about 3,500 different kinds. Ants are social insects — that is, they live and work in colonies — as do many bees and wasps. A colony of ants may consist of thousands of ants, each of which has its own particular duty to keep the colony going. Most ant colonies live in nests, either on the ground or in trees. Ant hills on the ground



Above: The male, queen, soldier and worker of the harvester ant.

Left: Some ants 'milk' greenfly by stroking them and obtain a sweet secretion called 'honeydew'.

Below: A group of leaf-cutting ants known as the Attini cultivate their own food. They grow fungus on beds of leaf particles stored in the nest.



Ants communicate with one another by rubbing their feelers together.





Left: The gorilla is the largest of the apes, standing six feet high and weighing as much as 600 lb.



Left: Gibbons' arms are so long that when standing upright they can touch the ground with their fingers.

Below: The body of the chimpanzee is more similar to that of man than any other animal.



contain many chambers and tunnels connecting them in which the ants store food and look after their young. A colony consists of a *queen* ant, *male* ants and *worker* ants.

The queen ant does nothing but lay eggs once she has started the nest, while the male ants' only duty is to mate with the queen. The actual running of the colony is carried out by the workers, small female ants that do not mate or lay eggs. The workers repair damage, build new parts onto the nest, collect the food and look after the eggs and young. Some ant species have special worker ants called *soldiers*. These use their powerful jaws to defend the nest from attack, either by other ants attempting to occupy the nest, or by birds in search of a feast. They can also sting an enemy by squirting an acid.

A colony is started by a queen after mating during a 'marriage flight' of male and female ants. The males soon die and the female loses her wings, as she finds a place to build a nest and lays eggs. These hatch to form a small colony of which the female becomes the queen. As

workers build up the nest the colony grows in size and numbers. It may last for many years, with a new queen replacing the old one when she dies.

Ants' eggs are very small and hatch out into larvae. These are small maggot-like creatures, quite unlike ants in appearance. A larva grows and sheds its skin several times. After a few weeks, it becomes a pupa, sometimes forming a cocoon around itself. The pupa remains in this stage without eating and hardly moving, while its adult body forms. It then breaks out to emerge as an adult ant.

Anzac is a name formed from the initial letters of the Australian and New Zealand Army Corps. This was a combined force of about 30,000 volunteer soldiers from Australia and New Zealand, formed in Egypt during World War I.

They became famous for their part in the Allied landing on the Gallipoli Peninsula in 1915. There they fought with great gallantry against the strongly entrenched Turkish troops. Although the operation itself was a failure, and the Allied soldiers had to withdraw after

eight months' bitter fighting, the Anzac contribution demonstrated a wonderful comradeship under terrible conditions.

The term Anzac sometimes refers to Australian and New Zealand servicemen who fought in other World War I campaigns, and some in World War II.

Apes are the most man-like of all animals. In fact, man is classed biologically with the apes in the *anthropoid* group. Unlike monkeys, apes have no tails. They are generally larger than monkeys. In general form, apes' bodies are much like man's, but their arms are longer and the legs shorter in proportion than a man's. Except for their faces, hands and feet, apes are covered in hair.

What most distinguishes the apes from other animals is their brain. They are the most intelligent creatures in the world apart from man. In captivity, they may acquire many almost-human habits. They can solve quite difficult 'problems' and can use sticks as primitive tools—to pull something within reach, for instance. In all apes, the co-ordination of hand and eye is well developed. They can use both hands and feet as we use our hands, to hold objects and do things.

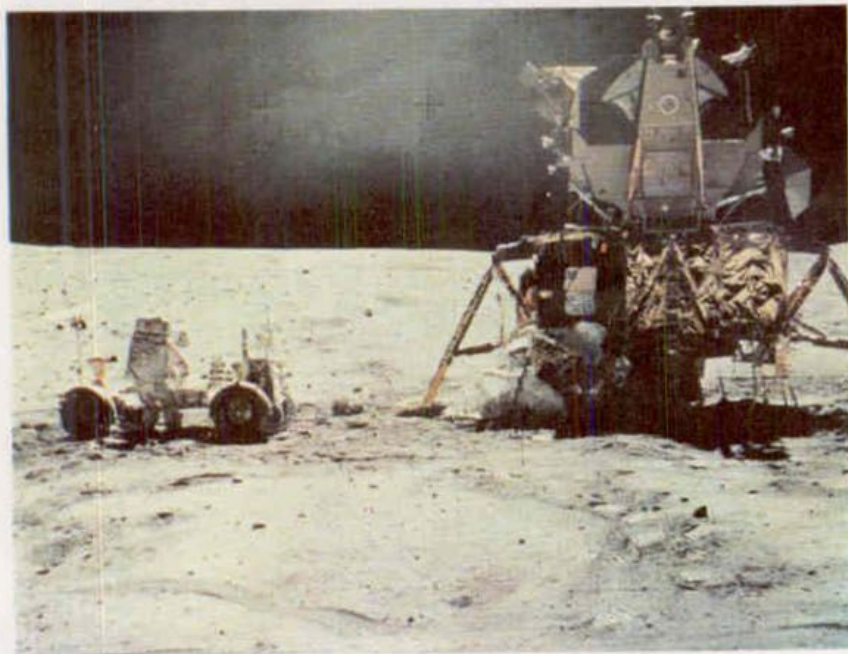
There are four main types of apes, divided into two groups. The *lesser apes* comprise several species of gibbons. The

more advanced *great apes* include the orang-utan, chimpanzee and gorilla. Chimpanzees and gorillas live only in Africa; the other species live in Asia. They all live in groups in forests, and eat fruit and other plant food.

Gorillas are by far the largest of the apes. They stand as high as a man and may weigh up to 600 lb—over 40 stone. They are immensely strong. Both they and chimpanzees live and move about on the ground, climbing to platforms built in trees to sleep. Chimpanzees can also swing from tree to tree, however. They are extremely intelligent animals, and have great curiosity. They love exploring.

Orang-utans are the only apes to live entirely in trees; they swing from branch to branch in the forests of Sumatra and Borneo, in Indonesia. Their name means 'man of the woods' and they may look remarkably human. Gibbons can also travel at great speed through the forests. They have extremely long arms and are smaller and lighter than the other apes.

Apollo Spacecraft This type of American spaceship first took men from the Earth to the Moon. It consists of three parts called *modules*. The *service module* is the largest part. Shaped like a cylinder, it contains the main engine and fuel cells to provide electricity. In front of



Astronauts from Apollo 16 used a lunar rover, or 'Moon buggy', to travel across the Moon's surface. They carried out a number of scientific experiments to find out more about the age and structure of the Moon.

the service module is the cone-shaped *command module*. The three astronauts sit inside this module, the Apollo spacecraft's control centre. Attached to the command module is the spider-like *lunar module*. This is the part of the spacecraft that lands on the Moon. The lunar module is divided into two *stages*. The lower half, the *descent stage*, contains the descent engine that gets two of the astronauts down to the Moon. The upper half, the *ascent stage*, contains the ascent engine that lifts the two explorers off the Moon.

The three-part spacecraft is sent on its way to the Moon by the great Saturn V rocket. When it nears the Moon, the main engine fires to put it in orbit round the Moon. Then two of the astronauts squeeze through a tunnel from the command module to the lunar module. They separate the lunar module and descend to the Moon. The other modules still circle the Moon. When the astronauts have completed their programme of exploration and scientific experiments, they lift off from the Moon in the ascent stage and rejoin the third astronaut in the command module. The ascent stage is then jettisoned and the command and service modules return to Earth. Just before re-entering the Earth's atmosphere, the command module separates from the service module, and splashes down in the ocean beneath its parachutes.

The first Apollo spacecraft to orbit the Moon was Apollo 8 at Christmas 1968. Apollo 11 became the first manned spacecraft to land on the Moon on July 20, 1969. Since then several other Moon landings have been made. Astronauts have carried out a number of scientific experiments on the Moon's surface and brought back to Earth samples of Moon rock, which have helped to determine the age and composition of the Earth's only natural satellite. Astronauts on later landings were able to travel several miles from the lunar module by means of a small vehicle, the lunar rover.

Talking points

* Do you think that the vast amount of money needed to send men to the Moon was wisely spent?

* Describe some of the ways in which the Apollo programme has affected electronics, alloys, and medical research. Can you

think of any household object which has been improved by space research?

* What are the everyday problems men must overcome in space travel?

Articles to read

Astronautics; computers; gravitation; rockets; space probes.

Appalachians The Appalachians are a mountain system in eastern North America. They stretch 1,500 miles from Quebec Province (Canada) to Alabama (United States). The Appalachians contain some of the largest coalfields in the United States, and are heavily forested.

They may be divided into five main parallel regions. In the west are the *Allegheny* and *Cumberland plateaus*. They include the Catskills at their northern end. Then comes the *Ridge and Valley* section. Next to this zone is the great Appa-

Gathering the harvest in a New Zealand orchard. Apples grow in temperate regions around the world.



lachian valley. The Blue Ridge forms the eastern heights. There the highest peaks are found. They include Mt Mitchell (6,684 ft) in North Carolina, and several others over 6,000 feet. The fifth zone is the *Piedmont Plateau*. The rocks composing the Appalachians are millions of years old, and have been gradually worn down by rivers and, in the north, by glaciers as well.

The Appalachians form a divide, separating the rivers that flow into the Gulf of Mexico from those that flow into the Atlantic Ocean. On the coastal plains to the east of the mountains stand the great cities of New York, Washington, Baltimore and Philadelphia.

Apples are a common fruit. They grow in temperate regions around the world, but not in the tropics nor in polar regions. Leading apple-growing countries include the United States, Italy, Germany, Japan, France, Australia and New Zealand.

Like most common fruits, apples belong to the rose family of plants. Other members of this family include the pear, peach, plum, cherry, apricot, blackberry, strawberry and raspberry. Wild apples, called crab apples, are hard and sour. But over several centuries man has cultivated apples that are sweet to taste. Apple growers have produced many different kinds of apples of varying sweetness.

Apples are a good fruit to eat raw. They are about five-sixths water, the remaining sixth consisting of sugar, ascorbic acid (vitamin C) and other acids, and rough indigestible matter that gives the fruit its bulk. Apples are also used for cooking sweet dishes, and cider is brewed from fermented apples.

Aquarium is a tank for keeping fishes and other water animals. It usually has glass sides for viewing the inhabitants.

The apple is a common symbol in religion and legend. The forbidden fruit that Eve offered Adam in the Garden of Eden is thought to have been an apple.



Exotic tropical fishes are fascinating to watch and easy to keep in a heated aquarium.

A home aquarium can easily be made with a glass tank bought from a pet shop. The bottom should be covered with a layer of sand and gravel one or two inches deep, and clean water gently poured in. Place water plants in the tank—these will provide the fishes with oxygen. Plants include *Elodea*, *Vallisneria*, and *Sagittaria*, but many others can be used. The aquarium should be kept in a bright place, though not in sunlight, or provided with a light bulb. For tropical fish, the water should be kept at 70°F (21°C) with an electric heater.

An aquarium can support only a certain number of fishes. For every inch of a fish's body, there should be 20 square inches of water surface for tropical fish and 24 square inches for non-tropical fish. If there are too many fishes, there will not be enough oxygen in the water and some fishes will rise to the surface and gasp. These fishes should be removed or an aerator used to bubble air through the water.

Aquarium fishes can be fed with prepared foods from pet shops. Goldfish will eat insects. Fishes should be given no more than they will eat in 10 minutes, and uneaten food should be removed.

Marine fishes are more difficult to keep in an aquarium, but they will survive if continually provided with clean sea water. An aerator is necessary, and the aquarium should be kept in a cool and dim place. Marine animals picked

up on the sea-shore, such as anemones and mussels, can also be kept in a marine aquarium.

Aqueduct Water often has to be transported from its source, such as a lake or river, to where it is needed for drinking, or irrigation, or for other purposes. The artificial channels built to carry the water are called *aqueducts*. The most familiar kind of aqueduct is an open channel carried by a bridge across a valley. But pipelines and tunnels are also classed as aqueducts.

The Ancient Romans were great builders of aqueducts, and many are still standing. One at Nîmes in France stands more than 150 feet high and has three tiers of massive stone arches.

Arabia is a large desert peninsula of south-western Asia, which is almost com-

pletely separated from Africa by the Red Sea. Arabia is the earliest known home of the Arab people. From its two 'forbidden' cities of Mecca and Medina (forbidden to non-Muslims) sprang the religion of Islam.

Most of the peninsula forms the kingdom of Saudi Arabia. The sheikhdom of Kuwait lies at the north-eastern corner of Arabia, at the head of the Persian Gulf. Seven sheikhdoms—called the United Arab Emirates—the sultanate of Oman, and the sheikhdoms of Bahrain and Qatar occupy the eastern coast of Arabia. The republics of Yemen and Southern Yemen lie at the southern tip of Arabia.

Most of Arabia is a dry wasteland where rain seldom falls and few animals or plants live. Temperatures often top 130° F (55° C) during the daytime in summer, but the nights are cool.

Arabia's only railway connects Riyadh, Saudi Arabia's capital, with the Persian Gulf. Jedda, on the Red Sea, is an im-

A massive three-tiered aqueduct built by the Romans near Izmir, Turkey.



portant sea and air port, handling pilgrims to Mecca and Medina.

Arabia came under Turkish rule in the 1500's. The British built a port at Aden in 1839, and by 1920 much of Arabia was under British influence. Until a genera-

tion ago, Arabia was one of the poorest and most remote places in the world. But geologists discovered petroleum in Arabia in the 1930's, and by the 1960's sales of petroleum had made Arabia rich. Saudi Arabia and Bahrain quickly developed socially and economically.

The transformation of Kuwait made possible by proceeds from petroleum was almost miraculous. The poor, sparsely-populated sheikhdom became, in the 1960's, one of the world's largest suppliers of petroleum and natural gas. It now possesses more wealth per head of its population than any other country.

Southern Yemen became an independent republic in November, 1967, following the union of Aden with other territories.

Arabs The Arab peoples came originally from the Arabian Peninsula, spreading until they founded a huge empire and culture, reaching from India to the shores



Above: An offshore drilling rig in the Arabian Gulf. Petroleum has brought great prosperity to Arabia.

Right: Location map of Arabia (marked in black).

Below: Modern Kuwait. Oil revenues have created sumptuous buildings and amenities in what was once an empty corner of the desert.



Arabs today are deeply conscious of their unity of language and religion. Gamal Abdul Nasser, the Egyptian head of state, was a leading figure in the upsurge of Arab nationalism, until his death in 1970.



of the Atlantic Ocean. Today the name Arab is given to all the inhabitants of the peninsula, and also to all people who speak Arabic, and claim their descent from the original Arab conquerors. They live chiefly in northern Africa and Iraq (formerly called Mesopotamia).

The great majority of these peoples are followers of the Muslim religion, and it was the zeal and inspiration of this belief which drove the Arabs to extend their empire from A.D. 650 to 850.



Today, Arabs are either town dwellers, peasants, or Bedouin. In towns, the Arabs are traders, craftsmen, shopkeepers, clerks and officials. The peasants live in villages and work small farms. Their life is hard, and their standard of living meagre. There are few modern methods or machines in use. In most places oxen still pull the ploughs, and camels and donkeys are the chief means of transport. The Bedouin are *nomadic* (wandering) tribes who breed and train camels. They live in tents which they set up for perhaps a month at a time as they move in search of water and grazing land. (See Bedouin.)

Arabs today are very conscious of their unity of language and religion, and are struggling to unify themselves politically, but deep differences still divide them.

Archaeology The archaeologist reconstructs the lives and activities of past peoples—how they made a living, what tools they used, what skills they had acquired, even what diseases afflicted them. The clues for building up these pictures are the traces such peoples have



left behind—bones, tools, ornaments, pottery and buildings.

The fractured bones of fallen warriors may reveal just what types of weapons were used in past warfare. Diseases may also leave their mark on the skeleton. The teeth of past peoples may reveal something of their diet. People who eat mainly meat rarely have rotten teeth. As the quantity of grain in the diet rises there is a tendency for tooth-decay.

Bones of animals may often be found associated with human communities, and their identification usually goes a long way to establishing the staple human diet. The remains may be of animals known to move from pasture to pasture—reindeer and bison, for instance. Almost certainly the human community also led a wandering existence.

The archaeologist works mainly by excavating a deserted site, from which he collects all the evidence of human occupation. Excavation today is a highly professional and scientific business, though the voluntary help of amateurs is often welcome. Often it is not possible to dig up the whole site, so the excavator plans trenches across it, perhaps at the corners, or straight through the middle. Each trench is marked out and its position on the map recorded. The trench is then sunk until virgin soil, earth untouched by man, is reached. First, the top layer of soil is carefully removed. Then each level or layer of earth underneath is carefully scraped away with builders' trowels. Different layers are revealed by changes in the colour of the soil. The position of everything found is carefully recorded, and important finds are photographed in position.

From these records the archaeologist draws plans of what was found in each level. Objects from the lower levels will be older than objects from the higher ones.

Left: Part of a harp dug up by archaeologists at Ur in Mesopotamia. It is over 4,000 years old.
Right: A Bedouin Arab beside his tent.



The archaeologist knows that one kind of broken pottery is older than another kind. But how much older? Occasionally a coin with a date is found with a particular type of pottery in one place. This gives a date for that kind of pottery wherever it is found. But much archaeology depends on arranging artefacts (pottery, flints, brooches, jewellery) into types, and trying to decide which type developed out of which other type, and when.

Recently a whole series of scientific techniques have aided the archaeologist to date his finds. One of the most accurate is the carbon-14 method. Carbon-14 is a radioactive form of carbon found in plants and animals. When living things die the radioactive carbon that has been taken in *decays*, breaking down to form nitrogen. The rate of this breakdown is constant. After 5,568 years half of the radioactive carbon has decayed. After another 5,568 years half as much again has disappeared. By measuring the quantity of radioactive carbon left in old wood, bones, peat, antlers and grain their age can be estimated.

A method of telling the relative age of human and animal remains involves testing the amount of fluorine they contain. Bones and teeth buried in the ground gradually absorb traces of fluorine. If bones found together contain the same amount of fluorine they are of the same age. This method proved the Piltdown skull to be a fake. Some of the bones were much younger than others.

Not all archaeology is done by excavating. By looking at a photograph taken from an aircraft we may discover the shape of a vanished building. Over the foundations crops will grow differently from crops on undisturbed ground. This difference will show clearly from the air.

Archaeology has revealed the secrets of ancient societies. It is also telling us new things about more recent times. Industrial archaeology is the study of old factories, mines and machinery.



Above: Modern archaeology is an activity requiring team-work and patience. Much of the work is carried out by voluntary helpers.



Left: Roman bronze cavalry helmet from Ribchester, Lancs. (late first century A.D.).



Below: Golden necklet from Caernarvonshire, Wales (c. 1700-1500 B.C.).

Archery The art of shooting with bow and arrow, also known as *Toxophily*, dates back to the Stone Age. Originally used for hunting, and in war, it first developed as a sport about the fourth century A.D. and has since enjoyed interest in various countries—particularly in Britain and the U.S.A.

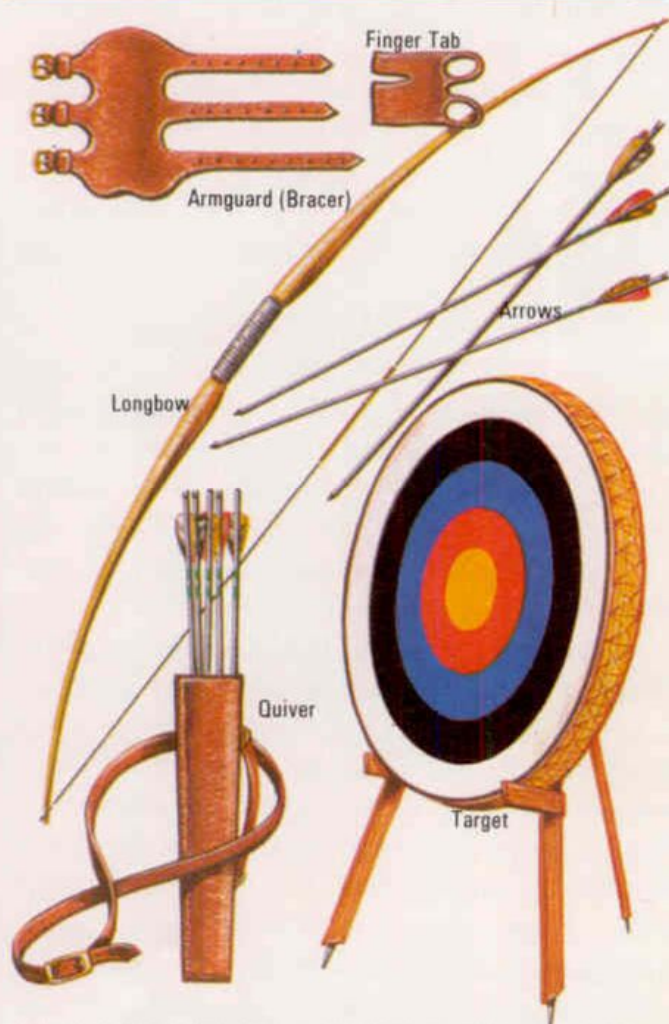
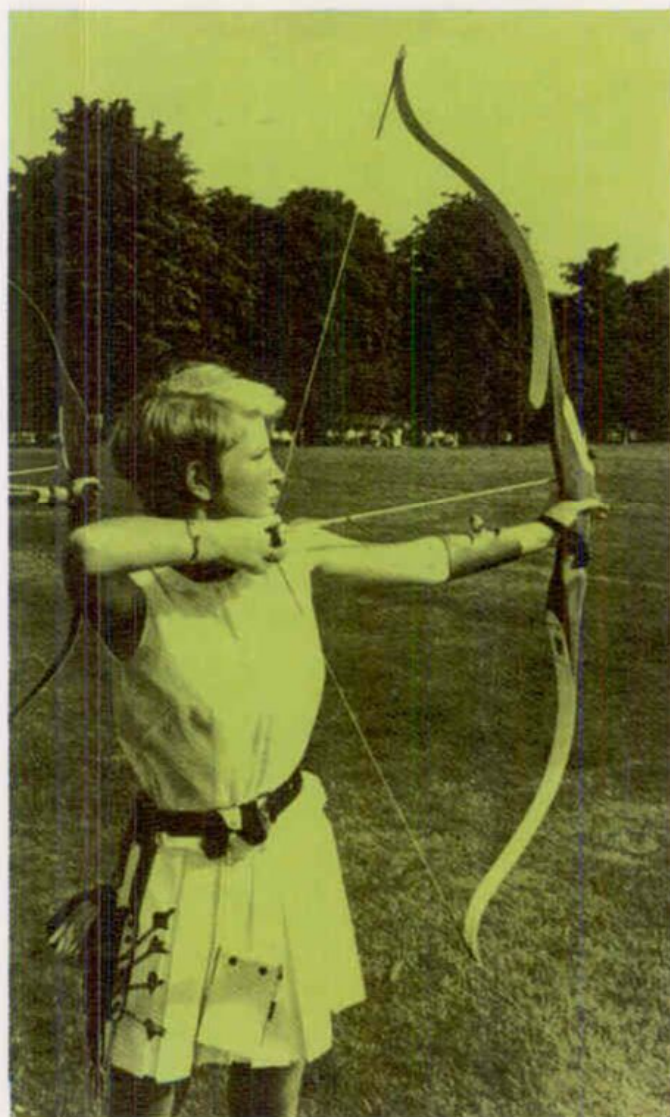
The most popular form of the sport is *target shooting*. The standard British target is circular, four feet in diameter. In the centre is a golden circle (the pin-hole) counting 9 points, and this is ringed by four concentric bands of (counting outwards) red (7 points), blue (5 points), black (3 points) and white (1 point). Scoring on an International Target is from 10 points for an inner gold to 1 point for an outer white (the colours themselves are divided on this target).

Any type of hand-bow may be used, the

simplest being the 6-foot English longbow of yew. The arrow is feather-flighted and about 28 inches long, depending on an archer's draw length.

The earliest modern contest was held in Yorkshire, England, in 1673. In the U.S.A. the United Bowmen of Philadelphia was formed in 1828, and the first tournament was held in Chicago in 1879.

Archimedes (287?-212 B.C.) was a Greek mathematician and inventor. He achieved advances in science unequalled for hundreds of years. Among his discoveries was the principle of buoyancy—an object placed in a liquid experiences an upthrust equal to the weight of liquid displaced. Legend has it that Archimedes discovered this when he stepped into a full bath and saw water spilling over the sides. He rushed out into the



Left: The correct stance for target shooting, the most popular form of archery.

street crying 'Eureka' (I have found it).

He also worked out the laws of levers and pulleys. These showed that heavy loads could be moved with a small force. Archimedes regarded his calculations of the areas of circles and other curves as his most important work. Much of it is still basic to mathematics today.

Archimedes was born and lived in Syracuse, Sicily. During the long Roman siege of the city, the enemy was held back by catapults which Archimedes invented. When the Romans finally entered the city, their general ordered his men to spare Archimedes. But he was killed by a soldier who failed to recognize him.

Architecture is the art and science of designing buildings. Man's basic needs have always been threefold: food, clothing and shelter. Before recorded history man was a hunter, moving from place to place in search of food, and living in natural caves or under the rough shade of trees. The story of architecture began when he started to grow crops and tend cattle. Only then did man look for ways to build shelters that would keep him safe from bad weather, wild beasts, and human enemies.

Architecture reflects the progress of mankind. It is the story, in brick and stone, wood and metal, of people and their ways of life. Architecture as we know it today began in the Nile valley of Egypt about 6,000 years ago, and we can still see its influence in some of our present-day buildings.

Egyptian architecture began about 3000 B.C. and ended in the first century A.D. The Egyptians, who left several massive pieces of architecture for us to examine, were often more interested in building tombs and temples than dwelling houses. The Sphinx, the Pyramids and other large monuments were enormously strong and built to last for thousands of years. The most famous Egyptian temple, at Karnak, was built in about 1200 B.C. and was made of stone. Most of Egypt's

Important Dates in the Development of Architecture

B.C.

- 3200 Rise of Ancient Egyptian Kingdoms. EGYPTIAN PERIOD begins. Great Pyramid of Cheops; Great Sphinx.
- 3000 Early Greek civilization
- 1800 Stonehenge begun
- 700 GREEK DORIC
- 525 Egypt becomes a Persian province
- 400 GREEK IONIC and CORINTHIAN
- 147 ROMAN PERIOD begins
- 146 Romans conquer Greece
- 30 Egypt conquered by Rome

A.D.

- 300 BYZANTINE PERIOD begins (Eastern Roman Empire)
- 400 EARLY CHRISTIAN PERIOD begins
- 500 Roman Empire begins to collapse
- 800 Crowning of Charlemagne
ROMANESQUE PERIOD begins (in Northern Europe)
- 1066 NORMAN PERIOD begins (in England)
- 1140 GOTHIC PERIOD begins (in France, First Gothic building, Choir of St. Denis, near Paris)
- 1175 NORMAN PERIOD ends (in England), Canterbury Cathedral is rebuilt bringing Gothic architecture to England
EARLY ENGLISH PERIOD begins
- 1200 ROMANESQUE PERIOD ends (in Northern Europe)
HIGH GOTHIC PERIOD begins (in France)
- 1245 Building starts on Westminster Abbey
- 1250 LATE GOTHIC and FLAMBOYANT PERIOD begins (in France)
- 1299 DECORATED PERIOD begins (in England)
- 1330 Choir of Gloucester Cathedral built (first building in Perpendicular style)
PERPENDICULAR PERIOD begins (in England)
- 1400 EARLY RENAISSANCE PERIOD begins (in Italy)
- 1485 TUDOR PERIOD begins
- 1500 HIGH RENAISSANCE PERIOD begins (in Italy Michelangelo)
- 1530 FRENCH RENAISSANCE PERIOD begins
- 1558 ELIZABETHAN PERIOD begins
- 1600 BAROQUE PERIOD begins (in Italy)
- 1603 JACOBEAN PERIOD begins
- 1650 BAROQUE PERIOD begins (in France)
- 1666 Fire of London
Rebuilding of London by Christopher Wren
BAROQUE PERIOD begins (in England)
- 1715 GEORGIAN PERIOD begins
- 1750 ROCOCO PERIOD begins (in France)
- 1811 REGENCY PERIOD begins
- 1837 VICTORIAN PERIOD begins
- 1920 MODERN ARCHITECTURE

N.B. Since the styles of architecture changed quite slowly, the dates given above are, in most cases, only approximate.

Over: Examples of stages in the development of architecture.



Egyptian: Temple of Amenhotep III (Luxor)



Greek Doric: Temple of Neptune, Paestum



Roman: Arch of Constantine, Rome



Byzantine: Santa Sophia, Constantinople



Romanesque: Pisa Cathedral



French Late Gothic: St. Ouen, Rouen



Italian Gothic: Milan Cathedral



English Decorated: York Minster



Roman Renaissance: St. Peter's, Rome



Baroque: Santiago de Compostela,



Anglo-Classic: St. Paul's Cathedral



Modern: Empire State Building, New York



smaller buildings were made of baked clay and reeds.

Greek architecture began about 700 B.C. and lasted until the country was conquered by the Romans in the second century B.C. The Greeks tried to be perfect in everything they did. They constructed their buildings on a simple column-and-lintel method. Rows of columns held up flat beams (*lintels*), on which the roof was placed. They worked out the details and proportions of their architecture carefully and built so well and so perfectly that their buildings are considered the finest and most beautiful ever to be erected.

When the Romans conquered Greece they copied the Greek architectural styles. However, the Romans had discovered how to make an arch, and could make larger buildings. The Romans used the Greek Orders of Architecture. These were the Doric, Ionic and Corinthian Orders, and were the styles, or decorations, of the column-and-lintel way of building. The fall of the Roman Empire ended what is now called the Classical

The Sydney Opera House is an example of the revolution in architectural design made possible by modern construction materials.

period of architecture, a period which began with the rise of Greek architecture.

In A.D. 800 the Romanesque period of architecture began. This was a style that imitated ancient Rome, but slowly took on its own character. The Norman architecture of England was late Romanesque. In 1140 the great Gothic period began in France, and came to England in about 1175. In 1200 the High Gothic period, with its tall cathedral towers and soaring masonry, began in France and spread through Europe.

In about 1400 the architects of Italy decided to build in the old Roman style again, and the Renaissance (the word means re-birth) began. Soon this new style from ancient days spread throughout Europe. Later, many famous architects started to change it to fit in with the times, and Baroque architecture was born.

Victorian architecture was due to another revival of ancient days. This time

it was the Gothic style. New materials, such as iron, were used.

Modern architecture began about 1920, and was the result both of new materials, such as re-inforced concrete and, later, plastics, and new ideas from bold and talented architects.

Talking points

* Draw a ground plan of your house. Can you think of any ways in which you could improve its layout?

* Today architects use many new materials. How have these altered the design of their buildings?

* Describe the differences that

climate and local materials have on the shapes of houses. Consider high-pitched roofs in Scandinavia, and houses on stilts in Borneo.

Articles to read

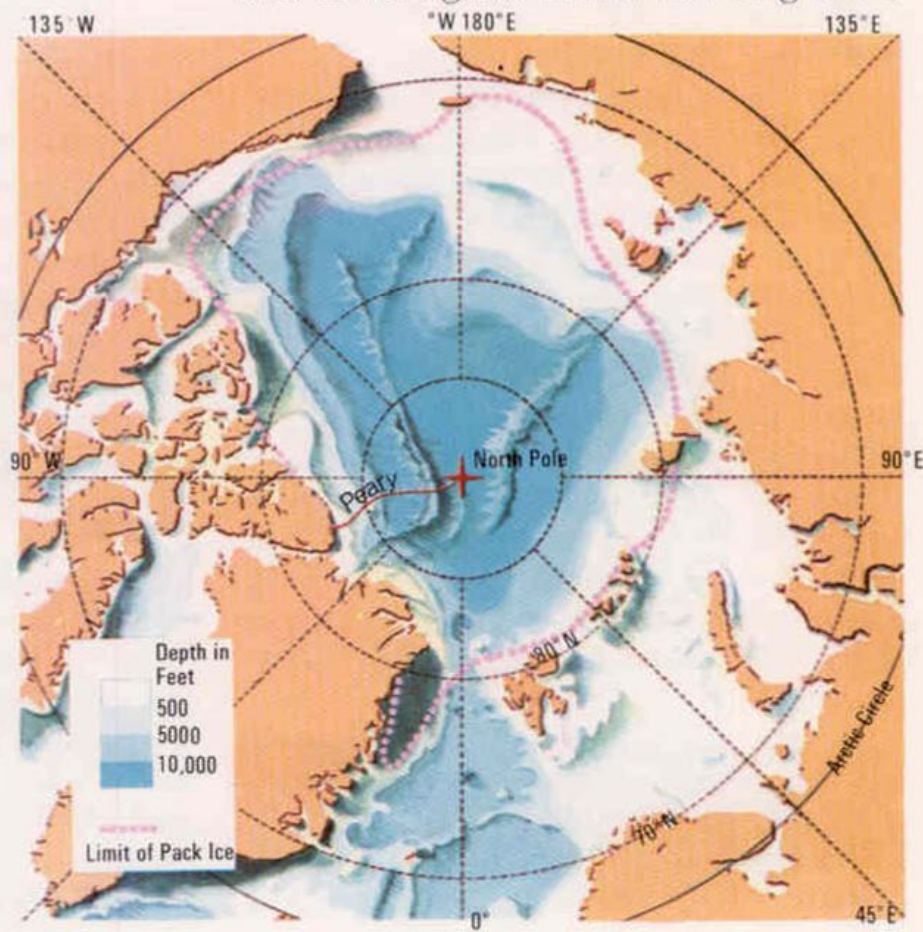
Building construction; Castles; Civil engineering; Town planning; Versailles; Sir Christopher Wren.



The colourful clothing of the Lapps who live in the far north of Scandinavia is a marked contrast to the bleak Arctic landscape.

Arctic The Arctic is the cold region around the North Pole. It includes the Arctic Ocean, which has an area of about 5,444,000 square miles. During the winter, pack-ice covers most of the Arctic Ocean. The ice is continually in motion, and as it grinds together large pressure ridges form. In the spring the ice begins to melt. Stretches of open water (*leads*) appear between the floes, and lakes form on the surface of the ice.

Animals are adapted in various ways to cold climates. Small ears help the Arctic fox hold in heat better than its southern cousin the red fox.



mosses and low shrubs. Reindeer and caribou graze in the Arctic in summer, but travel south in winter. Other animals include bears, ermine and foxes.

The largest group of people living in the Arctic are the Eskimos, who hunt and fish. In winter, some live in snow houses called *igloos*. Others live in half-buried huts. (See Eskimos.)

Arctic exploration began with the Vikings and continued in the 16th century, when Europeans sought north-east and north-west routes to Asia. But by the time that the routes were discovered, about 300 years later, other far easier sea-routes to Asia were known.

In 1909, a team led by the American Robert E. Peary became the first men to reach the North Pole. The first man to fly over the Pole was another American, Richard E. Byrd, in 1926. Today aircraft regularly fly over the Arctic region. In recent years many scientists have worked in the Arctic. For example, in 1968, a British team set out to cross the Arctic Ocean on drifting ice. They studied the climate, wild life and many other things.

Argentina is South America's second largest country. With Chile, it forms the southern part of the continent. It is a long, wedge-shaped country, bounded on the east by the Atlantic Ocean. Its western frontier with Chile runs through the Andes Mountains.

There are five main regions of Argentina. The Gran Chaco, in the north, is a grassy plain, liable to floods near the rivers and to a shortage of water away from them. Few people live there. South and west of the Gran Chaco is an arid area of rough country and low rainfall, where a few hardy plants and cacti grow. But along rivers are large fertile areas

The cattle of the Argentinian Pampas were herded by gauchos or Argentinian cowboys. They were often half Spanish and half Indian, and wandered from ranch to ranch. They hunted with a bolas, two or three heavy balls joined by ropes or thongs; they threw it to entangle the legs of their prey.



Above: The grassy plains of eastern Argentina (the Pampas) support large herds of beef cattle. Meat is one of the country's chief exports.



Left: Location map of Argentina (marked in black).

Facts and Figures

Area: 1,072,000 square miles.
Population: 24,300,000.
Capital: Buenos Aires.

where people grow sugar and fruit.

East of the arid area lie the Pampas, which are vast and fertile grassy plains covered by wheat and cattle farms. Patagonia, the southern part of Argentina, is largely desert. It has violent winds and little rain, and its winters are cold and unpleasant.

Most Argentinians are of Spanish and Italian descent, and speak Spanish. There are a few American Indians and *mestizos*, people of mixed Indian and European ancestry. Most people are Roman Catholics.

Farming is the main source of Argentina's wealth. The country exports great quantities of beef, mutton, wheat and other cereals, and sugar. Argentina produces natural gas and petroleum.

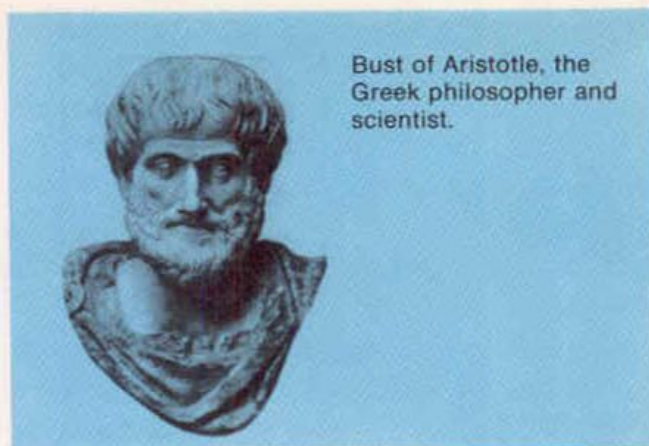
Spanish settlers colonized Argentina, then called the Rio de la Plata, in the early 1500's. The country remained under Spanish rule until the early 1800's, when the colonists, led by José de San Martín,

rebelled. Argentina became independent in 1816.

Argyllshire, a county on the west coast of Scotland, has some of the wildest Highland scenery in the country. Its coastline is much cut up by inlets called sea lochs, and is more than 2,300 miles long. A third of the country consists of islands in the Atlantic Ocean, including the Western Isles, which are part of the Inner Hebrides.

The people live chiefly by farming, and raise sheep and cattle. But, because the land is rough, they grow few crops. Other industries include fishing, tweed and knitwear, and mining.

Scots from Ireland settled in Argyllshire in the 400's A.D. and joined with the Picts to form the Kingdom of Scotland. Later St Columba brought Christianity from Ireland, establishing a monastery on Iona. Glencoe, in northern Argyllshire, was the scene of the massacre of the Macdonalds by the Campbells in 1692.

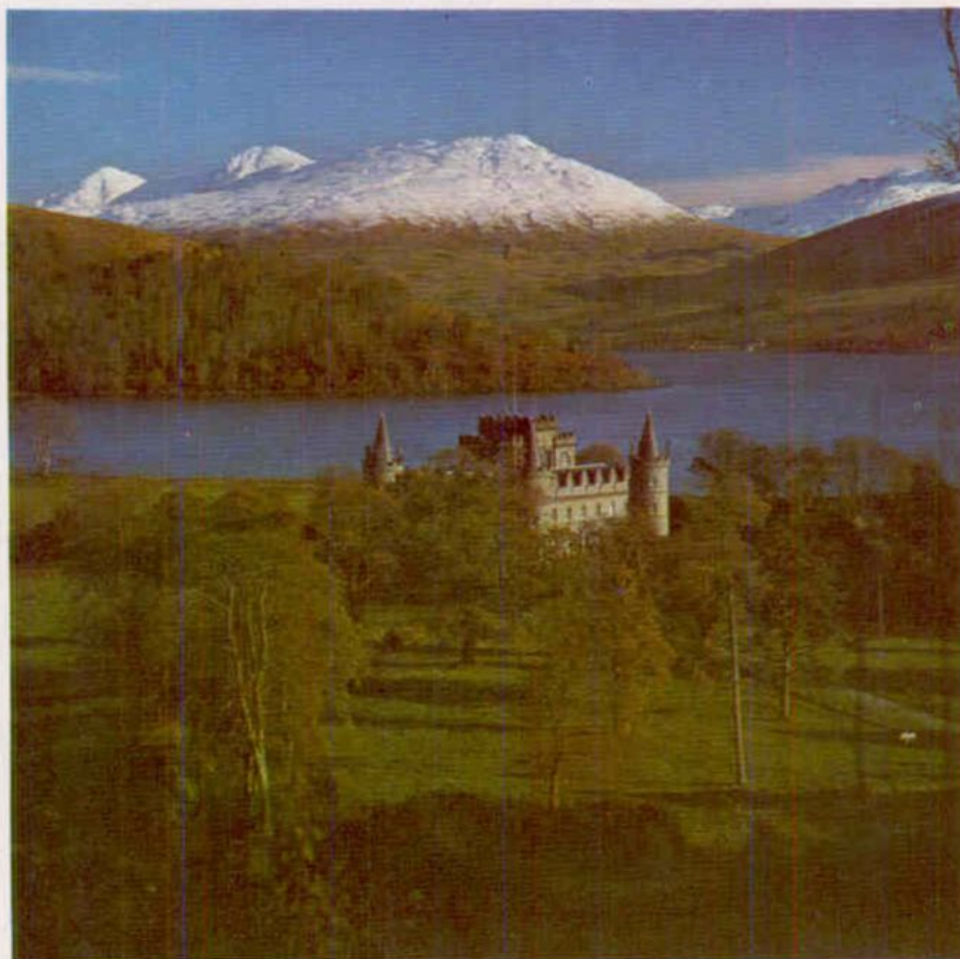


Bust of Aristotle, the Greek philosopher and scientist.

Aristotle was a Greek philosopher and scientist who lived four hundred years before the birth of Christ. His father was court physician to the king of Macedon. From his father, Aristotle received a good education in natural science.

When he was seventeen years old, Aristotle went to Athens, where he studied philosophy with Plato for twenty years. After Plato's death he returned to Macedon to become the tutor of Alexander the Great. Through Aristotle, Alexander learned to love and respect

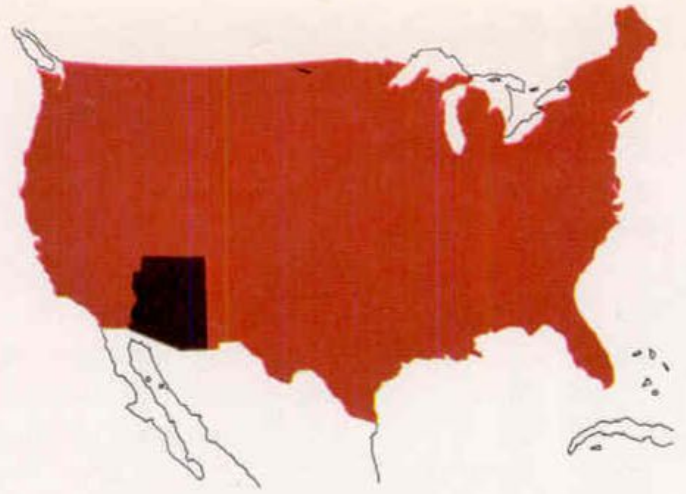
Loch Fyne and Inverary Castle, Argyllshire. This county, on the west coast of Scotland, is divided up by many inlets from the sea. Loch Fyne is one of these. Inverary is the county town.



the Greek language and the Greek way of life.

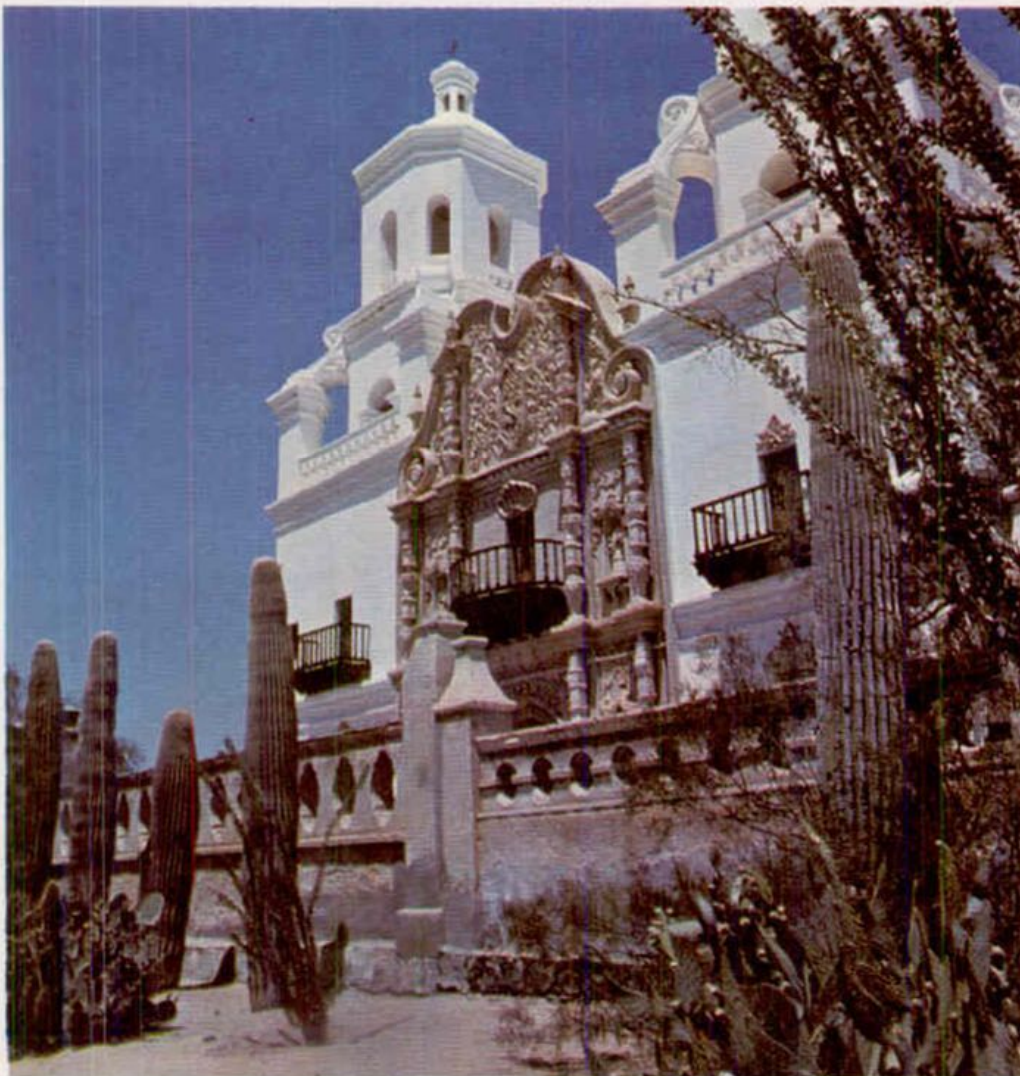
When Alexander became king, in 336 B.C., Aristotle returned to Athens as a teacher. Unlike his own teacher, Plato, Aristotle did not believe that beyond the real world which man experiences with his senses there is an ideal world which man can experience only with his mind. He believed that man must learn from what he can see, hear, taste, touch, and smell. He taught his students to examine the world around them in detail. Aristotle's thinking was far more systematic than Plato's.

Aristotle's writings span every area of human learning known at the time he lived. His ideas have been an important influence in the development of philosophy, political thought, psychology, natural science, and the criticism of drama.



The location map shows the position of Arizona.

Arizona is a state in the south-western United States, north of Mexico and east of California. It has an area of 113,909 square miles. Tourists flock to visit the 18 national parks and monuments that include the Grand Canyon, the Painted Desert, and the Petrified Forest.



An old Spanish mission in Tucson, Arizona. Arizona was explored by Spaniards from nearby Mexico in the mid-1500's, and a century later Roman Catholic missionaries were sent to Arizona to convert the Indians who lived there.

Agriculture is a leading source of income in Arizona. Livestock, especially cattle, are also important. Phoenix, the capital and largest city, is the chief agricultural centre. About three-quarters of Arizona's 1,752,000 people live in Phoenix and Tucson, Arizona's other major city.

During the 1950's and 1960's there was a large expansion of manufacturing industries in Arizona. Mining is also important, and copper is the leading ore. Electric power comes from plants at the Hoover, Roosevelt, and Davis dams.

In the 1530's, the first Spaniards reached Arizona hunting for gold, and Spain's hold on the territory lasted until 1822. Arizona became a state in 1912.

Arkansas is a state in the south-central part of the United States, on the west bank of the Mississippi River. It is bordered by Missouri in the north, Oklahoma in the west, and Louisiana and part of Texas in the south. The state has an area of 53,104 square miles, and a population of 1,886,000. The state capital and largest city is Little Rock. Forested hills, peaceful lakes, and the pleasant climate have made the state a popular holiday area.

Arkansas's most valuable resources are its fertile soil, mild climate, and large mineral deposits. More than half the land is used for farming. Cotton, soya beans, fruit, and vegetables are among the leading crops. Most of the state's in-

Oraibi in Arizona is one of the oldest inhabited settlements in the United States. It was built during the 1100's by the Hopi Indians, some of whom still live in the state.

dustries are based on agriculture. Several thousand people work in food processing and canning industries.

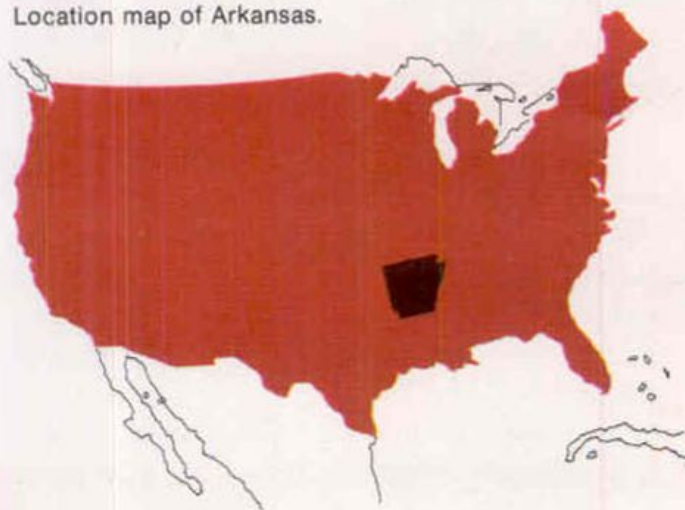
Arkansas was French territory until the United States bought it in the Louisiana Purchase of 1803. It became the 25th state of the Union in 1836.

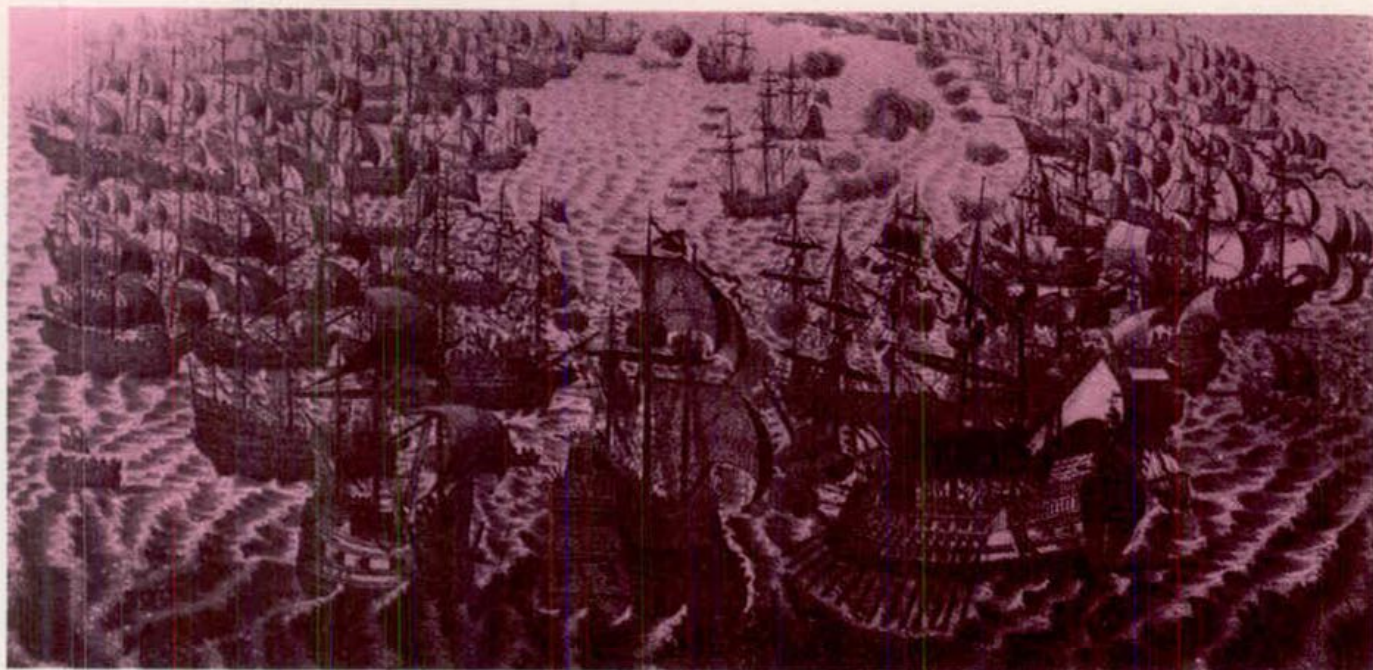
Armada This is the name given to the Spanish fleet which attempted an invasion of England in 1588 during the reign of Queen Elizabeth I. England and Spain were enemies for the latter part of the 16th century. English seamen such as Drake attacked Spanish treasure ships in South America. Finally, King Philip II of Spain decided to invade England. He collected a fleet at Cadiz. In 1587 this was attacked in harbour by Sir Francis Drake and the invasion had to be put off for a year.

In 1588 a large fleet assembled at Lisbon. There were 130 ships and 30,000 men, of whom 19,000 were soldiers. The force was commanded by the Duke of Medina Sidonia. The plan was for the fleet to sail from Spain across the Bay of Biscay and up the English Channel. Off the coast of the Netherlands the fleet would embark Spanish soldiers from the army there. The force would then invade England and depose Queen Elizabeth.

The English prepared for action and the main fleet under Lord Howard of Effingham moved to Plymouth. The Armada left Lisbon at the end of May but ran into storms and had to return to Spanish ports, finally leaving northern Spain in July 1588. When the Armada entered the Channel, the English fleet came out from Plymouth and attacked the Spanish ships. But the Spanish ships sailed close together, forming a large crescent, and the English attacks did not stop their advance.

Location map of Arkansas.





On July 28, the Spanish fleet anchored off Calais but the English created great confusion by setting old ships on fire and sending them among the Spaniards. The Spanish fleet lost its formation and was defeated on the following day in a general battle with the English fleet. The wind blew strongly from the south-west and the Spanish ships were forced to sail northwards and then round the coasts of Scotland and Ireland to get back to Spain. Many ships were wrecked on the way. Finally, broken ships and weary sailors returned to Spanish ports—the wreck of the ‘Enterprise of England’. Only half the ships that set out came back. The defeat struck a great blow at Spanish prestige.

An engraving representing the sharpest engagement that took place between the English and Spanish fleet against the Isle of Wight on July 25, 1588.

Some species can roll themselves up into a ball when attacked, the armour giving them complete protection. Armadillos have strong claws, particularly the giant armadillo, which grows up to four feet long. They use their claws to dig a burrow in which to live, and to smash open termite nests and ant-hills. These insects—together with earthworms, spiders and snails—form the armadillo’s main food.

Armed forces Since early times, nearly every state or country has considered it necessary to have forces of armed men ready to protect its citizens and territory from attack. In former times, most governments considered that their armed forces also had another role to play—to extend their countries’ territories by warfare, if possible.

Few people today would consider that any country—even their own country—has the right to add to its possessions by violence. For this reason, many modern armed forces are called *defence forces*, to emphasize that their role is defence, not attack.

The size of a country’s armed forces depends on a number of factors. The most



Bony armour protects the armadillo from its enemies.

Armadillos are strange mammals of Central and South America. Their backs are covered with armour, consisting of closely-fitting bony plates. In spite of this armour, armadillos are nimble creatures.

Right: A huge self-propelled gun. Weapons like this, which do not need elaborate equipment to get them into position, have made artillery more mobile.

Below left: A destroyer on exercises sails in a series of sharp turns to evade attacking aircraft. Manoeuvres like this are perfected in readiness for any possible war. The armed services of today are trained for defensive roles.

Below right: Women play an important part in the armed forces today. They are not usually fighting troops, but are used in support functions. This girl in the Women's Royal Air Force is an assistant air-traffic controller.





A Voodoo interceptor aircraft of the Royal Canadian Air Force. The invention of the aircraft has shifted the emphasis of modern warfare.

important factor probably is the amount of money available, though some countries appear to have forces that are much too large in relation to their wealth. The threats from neighbouring countries and from rebels within the country also have to be considered. And some countries seek to preserve their historic traditions of having certain kinds of forces.

Armed forces usually employ full-time professionals, whose careers consist of military service. But few countries can afford to employ full-time the number of people that they consider necessary to their safety. For this reason, most countries also have *reservists* of various kinds, who join their full-time colleagues in the event of war or other emergency. Some of these reservists are part-time members of the forces, who have civilian jobs and who train in the evenings, at weekends, and during their holidays. Others are men who have retired from full-time service.

A feature of contemporary armed forces is that many of their members are women. Since the Crimean War (1853-1856) most armies have had women nurses to take care of the wounded. In World War I (1914-1918) women performed many other military tasks, and since World War II, most countries have accepted that the women's services are an essential part of their forces. Although few countries consider it suitable to recruit women for their fighting troops (except for such duties as anti-aircraft gunnery), women take part in many support functions, such as transport, supply, and pay. There are also women staff officers, and women officers are important in the medical branches.

In almost all countries, the armed forces operate in three arms: army, navy, and air force. Until World War I armies

were by far the most important part of any country's armed forces. Navies had a vital part to play in keeping open the 'sea lanes' by which such countries as Great Britain maintained contact with their colonies and obtained foodstuffs and raw materials from abroad. But wars were won by armies, which destroyed their enemies' means of fighting and occupied their territories.

However, in World War II it became clear that air forces had a major, and perhaps all-important role to play. By destroying factories, roads, and railways, by putting ships out of action, and by terrorizing civilian populations, the air forces on both sides showed that they could vitally affect the course of war. When the Allies dropped atomic bombs on Japan in 1945, air forces for the first time in history brought a war to an end.

Although several countries now have nuclear weapons of such power that their use in war would lead to the devastation of vast areas of the Earth's surface, no country has yet employed them.

The armed forces of some countries are made up entirely of volunteers. Other countries *draft* or *conscript* all physically fit men to serve in the armed forces for a few years. The armed forces of all countries are still organized into army, navy, and air arms. Canada has unified its armed services, but the basic distinction between the various arms still exists.

Army. Most modern armies consist of combat troops, service troops, and staff. Combat troops are the fighting soldiers. They include infantry—soldiers who fight on foot, though they may be carried from place to place in vehicles; armoured troops—soldiers who use tanks and other heavy armoured vehicles in battle; and artillery troops—soldiers who fire the heavy guns. Some of these guns are towed by tractors, others are mounted on caterpillar tracks like tanks.

Paratroopers—troops who drop into battle by parachute—are an important part of modern armies. So are soldiers



Above: Paratroopers are distinguished by their red berets. Below: A Gurkha officer with the goat which is his regiment's mascot.



who fight from *gunships*, armed helicopters which hover over the battle area.

Service troops provide the food, clothing, ammunition, fuel, and other supplies needed by the combat troops. They include the engineers or sappers who build bridges, lay mine fields, repair roads, and construct landing strips. Service troops also include the members of the medical, dental, pay, and education services.

The staff consists of the commanders and other headquarters officers who plan and direct the operations of the army. They are trained in staff work, and also have experience with the combat or service troops.

Navy. The splendid battleships that were once the pride of great navies no longer have a function in sea warfare, partly because they are vulnerable to air and submarine attack. But some navies, including the U.S. Navy, the world's largest, still have some huge ships—aircraft carriers, which operate as floating airports.

The most deadly and effective craft in modern navies are probably the submarines. Some of these are powered by nuclear engines, and can remain away from base and under water for long periods. Some of them are equipped with nuclear weapons: in wartime such vessels could sail undetected within range of enemy territory, and use their weapons with devastating results.

For day-to-day functioning, navies rely chiefly on relatively small ships such as cruisers, frigates, and patrol boats. These carry efficient and complex weapons. Navies also have large numbers of specialized vessels, such as supply ships, tankers, commando ships (which carry troops and helicopters), and escort vessels.

Marines are 'seaborne soldiers'. In past centuries ships would have a company of soldiers on board who would act as landing parties. Today marines usually make airborne landings from commando ships.

Air force. Because of the development of rocket weapons, ideas about air warfare have changed greatly since the end of World War II. But most large countries retain their air forces.

An air force needs planes of many different kinds, because of the many tasks it has to carry out. Reconnaissance planes are designed to fly over enemy territory on 'spying' missions without being detected. They carry sensitive instruments to study the ground beneath them. Fighter planes are fast, easily manoeuvred aircraft designed to destroy attacking enemy planes. Bombers carry bombs or other weapons to attack enemy targets on the ground. They are large planes, and can fly long distances without refuelling. Transport planes carry supplies and troops. And helicopters have many short-distance functions as general 'maids of all work'.

Talking points

* How have modern armaments and better transport changed methods of battle? Compare siege, trench warfare, war in the air.
* Why and in what ways have armed forces become mainly defensive rather than offensive?

* What are the main roles played by women in modern armed forces?

Articles to read

Aircraft; Armada; Camouflage; Guns; Heraldry; Napoleonic Wars; Tanks; Uniforms; Warfare.

The aircraft-carrier *Ark Royal*. Huge ships like this act as mobile airfields, carrying short-range aircraft within striking distance of a possible target.

